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A Study of Receptivity and Technology Transfer in Small Engineering Companies

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ABSTRACT

This thesis addresses the problem of facilitating technology transfer to SMEs (Small and Medium Enterprises). The research sets out to explore the existing body of knowledge relating to the problem, and then by means of field research to seek pointers towards solutions.

The thesis builds on earlier research which identified weaknesses in the activities of information centred technology transfer intermediaries and called for a more interactive and consumer centred approach.

The research is particularly concerned with the concept of the 'Receptivity' of SMEs to the technology transfer process. The concept of 'Receptivity' is examined in the context of a wider conceptual framework.

The field research explores the problems and plans of a small sample of engineering companies in Luton as perceived by the owners or managing directors of the SMEs. The field research then seeks to establish how the same group perceive solutions to the identified problems and requirements to achieve identified plans.

The research suggests that the SMEs in the sample did not perceive the acquisition of technology as a problem nor did they perceive technology as a solution to their problems, or as a means to achieve their plans.

Conclusions are drawn and implications discussed.

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CHAPTER 1

1. INTRODUCTION

1.1 BACKGROUND TO RESEARCH

This research was undertaken in response to a particular set of circumstances, and related problems, encountered by the author as a result of his part time secondment to an organisation called the Eastern Region Technology Centre (ERTC). The research set out to explore the existing body of knowledge which related to these problems, and then by means of field research, to seek pointers toward solutions.

1.2 THE CIRCUMSTANCES

The author was appointed to a post as Project Manager at the Applied Research and Consultancy Centre at Putteridge Bury (part of Luton University) in August 1989. One of the projects allocated to him was the part-time management of the Bedfordshire office of the Eastern Region Technology Centre (ERTC) and the author was therefore seconded to the ERTC for one day each week.

The ERTC was the last of 13 Regional Technology Centres (RTCs) set up with government funding to 'help business - particularly smaller firms (SMEs) - to use and exploit modern technology by providing technology transfer services, helping with training, and offering expert advice' (ERTC promotional literature)

The ERTC was launched on the 13th September 1989 following a detailed feasibility study conducted by consultancy firm - Victor Hausner & Associates. The Hausner study proposed the establishment and structure of the ERTC and identified a broad technology transfer role for the organisation

"To facilitate, across the Eastern Counties, the effective transfer of technology and technological innovation between industry, from academia into industry, and from industry into academia, in terms of new products and processes". (Hausner, 1989)

and in terms of a client base for such services identified one specific group as 'small and medium sized companies with technology needs'

Therefore central to the activities of the ERTC and the other RTCs is the 'transfer of technology and technological innovation', with Small and Medium sized Enterprises (SMEs) identified as specific recipients for this service. The ERTC's role is that of an intermediary, and as such RTCs are normally classified as technology transfer intermediaries. The first three of the 'objects' clauses in the Memorandum of Association of the ERTC sets out its role in greater detail

"The Company's objects are:

(a) to promote and facilitate the transfer, adoption and use of existing, new and improved technology in the Counties of Norfolk, Suffolk, Essex, Cambridgeshire, Hertfordshire and Bedfordshire (the Eastern Region) so as to increase its industrial competitiveness and viability, stimulate investment and generate opportunities for employment;

(b) to develop, organise, provide or manage facilities for the promotion of collaboration between existing and proposed industrial and commercial enterprises (with particular reference to small and medium sized enterprises) in the Eastern Region and the Educational Institutions and Research Establishments in order to make available to such enterprises information, advice, technology and research contracts, and training;

(c) to develop, organise, provide or manage a service for the introduction of proposed or existing industrial or commercial enterprises (with particular reference to small and medium sized enterprises) in the Eastern Region to potential sources or users of technology or persons with whom they might combine or co-operate or from whom they might obtain financial or other assistance for the purpose of transferring, applying or exploiting technology;"

Certain linkages can be noted here, which are explored later in this thesis. Technology transfer is often linked, or sometimes assumed to be synonymous with, technological innovation and both technology transfer and technological innovation are seen as mechanisms to improve industrial competitiveness. SMEs are singled out as needing particular assistance, with respect to technology transfer, and by implication, with respect to technology transfer, as a mechanism to improve industrial competitiveness.

1.3 THE PROBLEMS

RTCs had been allowed to evolve as autonomous organisations and a diverse range of organisational structures had emerged, with equally diverse approaches toward the provision of technology transfer services. No paragon of structure or operation had emerged, and indeed some RTCs were, even at that time, struggling to survive. However a general feature of their experience

was their disappointment with the level of technology transfer activity with SMEs. It therefore became apparent, very early in the secondment, that there were no reliable guidelines available as to best practice for technology transfer activities involving SMEs. In addition some of the initial fieldwork with the objective of interesting SMEs in technology transfer, and of 'discovering' the 'technology needs' of local SMEs did not seem to be providing indications of any clear route forward.

The ERTC had therefore been tasked with a role of facilitating technology transfer to SMEs without any clear guidance as to how this could be achieved. The experiences of the other RTCs offered little in the way of help. Most of the RTCs claimed to have conducted 'needs surveys' among SMEs, which demonstrated the need for technology transfer, but despite the many and varied approaches to provision, none of the RTCs seemed to have found an effective means to facilitate technology transfer to SMEs.

The ERTC had already embarked on a number of activities

1. The construction of a database to enable matching of technologies with companies.
2. The publication of a regular newsletter.
3. Organisation of meetings, fora, seminars and conferences.
4. Construction of an index of academic skills.

but none of these activities seemed to be leading to any significant technology transfer activity involving SMEs.

There was, therefore, an immediate need to develop an understanding of 'technology transfer', and to seek pointers to effective strategies or mechanisms to facilitate technology transfer to SMEs. As a result this piece of research was sponsored by the ERTC with the intention that it would contribute to this understanding and might provide some pointers for the future role of the ERTC.

1.4 THE WIDER CONTEXT OF THE UK ECONOMY

The establishment of the RTCs, the interest in 'technology transfer' and the requirement for research of this type also needs to be set against the background of the present government's concern about the UK economy. Peter Lilley (Secretary of State for Trade and Industry in 1991) announced the drive for an 'innovation culture' as one of the key remedies for UK economic ills. He identified his view of the weaknesses in the UK economy

"The true weaknesses in the UK are:

our failure to exploit commercially the huge investment in the public sector science base; and
the still relatively low propensity of private industry to invest in R&D" (Lilley, 1991)

He also expounds the vital role of the process of innovation

"Innovation has always been the prime source of economic growth. Countries do not grow richer by making more of the same old things in the same old ways.
Sustained growth requires the continuous introduction of new products, made by new processes, often by new firms, using new designs, deploying new skills and opening up new markets" (Lilley, 1991)

and recent DTI publications now exhort

"Profitable innovation - the successful creation and commercialisation of new products, services or ways of doing business - is the lifeblood of successful companies" (Innovation Advisory Board, 1992)

Others have been more blunt by denouncing the UK's recent poor economic performance and then pointing to innovation as the remedy.

"The recent economic performance of Britain - compared with that of other industrial countries - has been inadequate"
"For three decades British growth rates have been relatively low, unemployment has been relatively high and investment activity has only recently begun to recover after a period of virtual stagnation. By almost every measure, Britain has done worse than many of her industrial competitors" (Roy, 1990)

These statements from a report commissioned by the Design Council express their concerns about the British economy. The report points out that in the twenty years since 1970 the UK's share of goods exported by major manufacturing countries has fallen from over 11 per cent to around 8 per cent by value, and is still falling, while the proportion of imported manufactures has approximately doubled in value.

The report concludes that the causes of the ups and downs of the UK economy during the past decade are complex

"However one factor that appears to be consistent is the relatively poor competitive record of British manufacturing." (Roy, 1990)

The remedy, again, is identified as innovative activity in order to remain competitive, however, the report also draws attention to the need for UK companies to adopt and use externally developed technology.

"Companies cannot be technology leaders in all of their business, all of the time. Ninety-five per cent of all technology is developed outside the United Kingdom. For British firms to remain internationally competitive, it is necessary for them to search worldwide for new ideas" (Hogg D. in Roy,1990)

In summary there is growing national concern about the performance of the UK economy and about the ability of British industry to compete effectively in world markets. Industrial innovation (including the appropriate use of technology) has been identified as a fundamental component of industrial success. As a result a number of measures (including the establishment of RTCs) have been taken to try to increase innovative activity and the effective adoption and use of new technology.

"From semiconductors to supercomputers, jumbo jets to HDTV, technology is probably the single most important factor driving the evolution of global competition. The accelerating pace of technological innovation is spawning new businesses, transforming old ones, and redefining the rules of competitive success" (Branscomb, 1992)

Internationally too, the same problems and same identified solutions are being encountered.

"In the United States, the current budget deficits and trade imbalances, rising capital needs, more demanding community expectations for economic development and especially more intense international competition in global markets now require leaders to develop better and new ways to transfer and commercialise science and technology"(Kozmetsky G. in Williams F., 1990)

1.5. THE IMPORTANCE OF THE ROLE OF SMEs

For some time now, SMEs have been identified as having particular characteristics which enable them to play an important innovatory role in the economy (although recently there has been some dispute over the evidence - see Oakey,1990). Rothwell and Zegveld for example conclude

'To summarise, we can say with some confidence the recent surge of interest on the part of governments in SMEs has been vindicated by the evidence presented. SMEs have been, and in general continue to be, technologically innovative, technology· based SMEs do play an important part in the emergence of new technologies and in economic growth; SMEs, and in particular young technology based SMEs do make an exceptional contribution

to employment creation; SMEs and again especially young independent SMEs do represent an important vehicle for regional regeneration; SMEs are important to social policy as well as to technology policy' (Rothwell and Zegveld, 1982)

Therefore, although this research was originated in response to a specific set of circumstances and the related problems, it reflects the perceived national and international generic requirement for effective mechanisms to facilitate technology transfer to SMEs.

In the European context, Price Waterhouse/Umist in a recent report on the role of technology transfer in SMEs summarise the position

"There is considerable discussion within the European Community on the benefits of technology transfer. This is seen as a major vehicle for stimulating business growth, competitive advantage and transnational co-operation within the European Community. However, successful transfers tend to be rare, and indeed only a few small and medium sized companies consider this route as a business development option (either transferring in or out)" (Price Waterhouse/Umist, 1991)

1.6. SCOPE OF THE RESEARCH

This research builds upon a foundation of work carried out by The Innovation and Technology Assessment Unit (INTA) at Cranfield Institute of Technology. In particular this thesis links to an investigation into 'Technology Transfer and the Role of Intermediaries' (Lefever, 1993) which identified that a mismatch existed between the needs of potential innovators and the activities of information centred technology transfer agencies. Lefever used and developed a process based conceptual framework originated at INTA which is discussed later in this thesis. Application of this framework to the work of intermediaries led him to the conclusion that the technology transfer agencies concentration on facilitating access to technology and technology related information was in itself inadequate. He proposed that there was a need to adopt a more consumer need centred and interactive approach suggested by his conceptual framework. He also identified the concept of the 'Receptivity' of the consumer as a critical element in both the level and success of the technology transfer process.

Lefever's findings clearly could be seen as potentially fitting the problems being encountered by the RTCs in that most of their activities could be considered as 'information centred', and indeed these were proving to be inadequate to stimulate any significant technology transfer activity involving SMEs. This research, therefore assumed the conclusion of Lefever's work and

set out to investigate the concept of Receptivity and its implications for technology transfer, in the specific case of SMEs.

The research did not investigate the role of intermediaries in technology transfer, or the more vexed question of assessing the value of intermediaries in assisting with technology transfer as these problems were addressed by Lefever. It was also decided that the research would not question the desirability of technology transfer to SMEs or the relative importance of SMEs in the economy.

1.7 OVERVIEW OF RESEARCH

The research, therefore, assumed a requirement (by, for example, an agency or by government) for an improvement in the process of technology transfer to SMEs, as part of a strategy to make SMEs more innovative. Given this requirement, the research set out to investigate the concept of 'technology transfer', and its relationship with innovative industrial activity as a whole.
The research then examined relevant theory, in conjunction with the framework developed by Lefever, in order to develop an understanding, in the specific case of SMEs, of, conceptually, how technology transfer may occur, and specifically the nature and role of 'Receptivity'. Field research was then carried out to explore the application and implications of relevant theory to the specific case of a sample of SMEs within the engineering industry.

The field research consisted of three phases of research activity with each phase evolving out of the previous phase. An initial round of informal discussions were held with a small number of SMEs, with the researcher in the role of an ERTC officer. This first phase served only to confirm the paradoxical findings stemming from Hausner, and the subsequent findings of the RTCs. In response to questions about technology, and technology transfer, SMEs stated that they appreciated its importance and the need for technology transfer services. However faced with the opportunity to participate in technology transfer, or to make use of technology transfer services, they were failing to do so.

The second phase of research consisted of a formally designed semi-structured interview with a selected sample of SMEs. This phase of the research was conducted with the researcher in a new role, in order not to orientate the interview around technology. This phase of the research was designed to elicit the problems and plans of the SMEs, and then to seek insight into the SME's perception of solutions to the identified problems, or the means to achieve identified plans. The SMEs were therefore providing their own agenda of problems and plans and then their own perception of solutions and means. This second phase found that firstly, the SMEs interviewed did not generally identify the acquisition or use of technology as a problem, however the

acquisition and use of technology, along with other technology related objectives, did feature strongly in statements of their plans. Secondly they did not perceive (or rate highly) the acquisition or use of technology (with one class of exception) as a solution to their problems, or as a means to achieve their plans, even though, in many cases it would have been a valid option for consideration. In terms of need (the things identified by SMEs as necessary to solve their problems, or achieve plans) SMEs seemed to be unwilling, or unable, to express their requirements in terms of technology or technological innovation. Propositions stemming from the second phase are examined and the implications considered.

The third phase of the research consisted of a follow up round of semi-structured interviews with the same sample of SMEs. This time the interview specifically addressed the previously identified problems and plans of the SME in the context of technology as a solution to their problems, or as a means to achieve their plans. This phase of the research concluded that, generally, SMEs are able to make linkages between their problems and plans, and either internal or external technology. It appears that for certain types of problem, SMEs find it easier to make linkages between their perceived problems and plans and the use or acquisition of technology. For certain other types of problem the SMEs seem to be pre-occupied with purely commercial solutions or means, and even when directed to a technological solution, seem to be unable or unwilling to perceive a link between their problem or plan, and a technological solution. Propositions stemming from the third phase are examined and the implications considered.

Finally conclusions from the research are drawn, and implications for policy and future research considered. A number of issues raised by the research are also discussed.

1.7 OTHER RELEVANT BACKGROUND INFORMATION

Researchers seek objectivity, however there are often factors which may be considered to have bearing on this objectivity.

There are two relevant pieces of background information that should be borne in mind by the reader:

1) In the Autumn of 1992 the author of this thesis won a DTI SMART award (Small Firms Merit Award for Research and Technology) and became the proprietor of a small electronics company. His role therefore changed from that of external observer of SMEs to that of internal participant.

2) The ERTC pursued the role proposed by Hausner by continuing with its existing programmes and techniques (essentially improving access and facilitating acquisition of known technology). It was unable to establish any volume of technology transfer activity involving SMEs and ran out of money and suspended operation during 1993.

CHAPTER 2

2. TECHNOLOGY TRANSFER AND RECEPTIVITY A DISCUSSION OF IMPORTANT TERMINOLOGY

Central to this thesis are the concepts of 'technology transfer' and 'receptivity'. Both terms are used in the literature in a variety of different contexts and by researchers from different disciplinary backgrounds. The terms take on shades of meaning both from the context in which they are used, and from the researcher using the term. It is therefore suggested that a search for any 'absolute' definition would be fruitless and would serve no useful purpose. It is however important for each context and for each researcher to have some understanding about the particular meaning attributed to the terms for that particular piece of research. For this particular researcher, and piece of research, the following discussion attributes this appropriate meaning.

2.1 TECHNOLOGY TRANSFER AND INNOVATION

The immediate concern of this research is with 'technology transfer' The term is now widely used, in many different contexts, often without any clear attempt to define the term, and as a result there seems to be considerable confusion as to what 'technology transfer' is. In a survey of SMEs in the North West, jointly carried out by Price Waterhouse and UMIST Ventures, 26% of the respondents were unable to define the term and

"The proportion of people interviewed who could not define 'technology transfer' understates the lack of previous awareness of the term - many made an educated guess at the definition from the words used. A number of respondents believed that the terminology gave an impression of high academic involvement and, as such, had little relevance to them" (Price Waterhouse/UMIST, 1991)

Findings of this type immediately start to ring warning bells about investigations or questionnaires that employ the term 'technology transfer' and make it vital to discuss the term, and to arrive at a working definition for the purposes of this thesis.

Some of the confusion about the term 'technology transfer' would seem to stem from the relationship between technology transfer and innovation. Often the terms are used interchangeably with publications dealing with technology transfer often then referring to a whole range of innovative activities.

As the term 'technology transfer' is constantly linked to the wider concept of innovation it is proposed to examine 'innovation' before focusing in on the term 'technology transfer'.

2.2 INNOVATION

The Oxford dictionary provides the following definitions:

Innovate
1. To change into something new; to alter; to renew.
2. To bring in (something new); to introduce as new.
3. To bring in or introduce novelties; to make changes in something established; to introduce innovations.

Innovation is therefore about changing or creating something new or novel. As a general concept it can be applied to a wide range of human activity (e.g. innovative writing style, innovative gardening technique) and clearly the context in which a term is used partially determines the attributed meaning.

Rogers (1983) uses this broad approach but also relates innovation to the perception of a recipient or target for the innovation.

"An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption"

The newness of an idea, practice, or object is in the perception of the adopter. An innovation for one group of adopters may not be an innovation for another group.

The interest of this thesis, however, is in a particular sector of innovative activity and although the term 'innovation' is used in this thesis 'scientific and technological innovation' is implied, as well as the context of the commercial production of goods, processes or services.

"Scientific and technological innovation may be considered as the transformation of an idea into a new or improved saleable product or operational process in industry and commerce or into a new approach to a social service. It thus consists of all those scientific, technological, commercial and financial steps necessary for the successful development and marketing of new or improved manufactured goods, the commercial use of new or improved processes and equipment or the introduction of a new approach to a social service." (OECD, 1981)

This often quoted definition views innovation as a transformation process embracing a very wide range of activities (scientific, technological, commercial and financial) which result in ideas being transformed into new or improved saleable products, processes or services. In fact it could be argued that innovation, in the spirit of this definition, comprises of all, or any, activities involved in transforming ideas into new or improved saleable products,

processes or services. The use of 'saleable' in this particular definition serves to provide the pointer as to the effects or outcome of the process i.e. new or improved saleable products, processes or services.

This definition identifies scientific and technological activities as part of the range of activities contributing to the innovation process. This view is supported by other writers (Kelly, 1978).

2.3 TECHNOLOGY TRANSFER

Very broadly the term Technology Transfer can be taken to refer to the transferring of technology from some source of technology, to some user, applier or consumer of the technology.

Leonard-Barton of the Harvard Business School considers that technology is capability, and explains this as the physical structure or knowledge embodied in an artefact (software, hardware, or methodology) that aids in accomplishing some task. Transfer, she proposes, refers to transformation of a technical concept into a development state closer to its end use, in the production of a service or goods and then finally proposes that Technology Transfer

"usually involves some source of technology, possessed of specialised technical skills, which transfers the technology to a target group of receivers who do not possess those specialised skills and who therefore cannot create the tool themselves." (Leonard-Barton D. in Williams F, 1990)

Many other writers use the term to also embrace mechanisms of transfer (e.g. dissemination of information, movement of personnel) and to imply appropriate deployment or application. Hough (1975), for example, explains that technology transfer "generally refers to disseminating information, matching technology with needs, and creative adapting of items for new uses"

Others (Bradbury F, 1978, Essoglou 1975) focus on technology transfer leading to some 'new use' and suggest that the technology transfer process is the volitional adaption of a technology originating in one institution or system for use in another.

The Hausner study adopted an organisationally rooted definition

"the transfer from one organisation to another of any artefact or knowledge relating to a product or potential product and its manufacture"

Price Waterhouse and Umist Ventures define the term similarly but detail donors and recipients.

"The transfer of products, ideas or know-how from one organisation to another. Donors can include (UK) companies, overseas companies, research laboratories, academic bodies or individual inventors whilst recipients can be companies of all sizes" (Price Waterhouse, 1991)

It will be noticed that these definitions do not refer explicitly to innovation or to any link between innovation and technology transfer. However the ultimate objective of technology transfer, either stated or implied, is new or improved, potential or real, products, processes, services or artefacts. The tangible outcomes or effects of successful technology transfer are the outcomes or effects of successful innovation.

One explanation which would seem to satisfactorily link technology transfer and innovation is that proposed by Seaton and Cordy Hayes

"the process of promoting technical innovation through the transfer of ideas, knowledge, devices and artefacts from leading edge companies, R&D organisations and academic research to more general and effective application in industry and commerce" (Seaton R, Cordey-Hayes M, 1993)

Here technology transfer is seen as a process contributing to, or promoting technical innovation, and this, it is proposed, for the purposes of this research, is an appropriate approach to clarify the relationship and the distinction between technology transfer and innovation.

It is proposed that technology transfer, for the purposes of this research, can be seen as a process that occurs within, and contributing to, the wider process of innovation. The OECD defines innovation to cover all activities or processes which enable the transformation of ideas into new or improved saleable products processes or services. Technology transfer can be seen as an important facilitating process assisting or enabling the wider process of innovation.
As with other processes it may be possible to observe the process, as the process occurs, or alternatively, if the effects of the process are known, to infer that the process has occurred from an examination of effects or outcomes. The result of successful technology transfer can therefore be seen as a higher level of innovation and the tangible (observable and measurable) outcomes are therefore the fruits of innovation, new or improved products, processes or services.

It is suggested that innovation can occur independently from technology transfer (new products can, for example, be devised using existing in-house resource). A business developing a new product line is involved in the process of innovation. The business may choose to develop any enabling technology needed for the product, its production or marketing, from within its own

organisation and human and technical resources. Alternatively, it may acquire the enabling technology from outside the business by engaging in the process of technology transfer. The business may, for example, take a license, acquire a new engineer, retrain existing staff or engage a consultant.

2.4 INNOVATION AND TECHNOLOGY

In the light of previous discussions is also suggested that new technology can be seen as one of the products of the innovation process. New or improved manufactured goods, or new and improved processes, can in themselves constitute the technology (the capability) which provides a further input into the innovation process. Conceptually this suggests that innovation could be envisaged as a spiralling process, with an ever growing core of products, processes and services at the centre, and with technology as both one of the possible inputs and one of the possible outputs. Technology transfer can be envisaged as one of a number of mechanisms by which technology is fed into the innovation process, both back into the innovation process from the innovation process itself, and from outside, from other sources of technology (e.g. from scientific research).

This argument has important implications when considering technology transfer in relation to other fields of study. It will be argued later in this thesis that findings in the fields of both marketing of technology, and diffusion of innovations, have important implications for the concept of receptivity and for technology transfer. Technology transfer, for example, can occur, it is proposed, as a result of both the marketing of technology and the diffusion of innovations. Marketing and diffusion can be seen as mechanisms by which the technology transfer process can occur. Leonard-Barton even considers diffusion of innovations to be a 'model' of technology transfer

"Diffusion of innovations, the study of 'the process by which innovation is communicated through certain channels over time amongst the members of a social system'(Rogers,1983) is a well known model of technology transfer, both among sociologists and market researchers" (Leonard-Barton in Williams F., Gibson D., 1990)

2.5 RECEPTIVITY

The Oxford dictionary defines 'receptivity' as

"ability or readiness to take in or receive"

In an organisational setting receptivity can broadly be seen to refer to the ability of the organisation to take in or receive, and in the context of technology transfer its ability to take in or receive, and utilise technology.

"An organisations overall ability to be aware of, to identify, and to take effective advantage of technology we refer to as receptivity" (Seaton R., Cordey-Hayes M., 1993)

Receptivity can therefore be seen as being determined by certain characteristics of an organisation.

The organisation's level of awareness of technology will be influenced by a combination of internal and external factors. These would include the education, abilities and actions of its staff, the nature of its interaction with suppliers, customers and other organisations and its information scanning, searching and reading activities.
The ability of an organisation to identify technology as appropriate will largely depend on the organisations ability (internally or externally influenced) to make linkages between its objectives, plans and problems, and technology as an appropriate means or solution. Only when these linkages have been established will the organisation be in a position to articulate its requirement for technology. An organisation has to know what it wants before it can acquire it !
An organisations ability to take effective advantage of technology will relate to factors such as its ability to purchase or acquire, its ability to transfer or customise, and the abilities of its staff to deploy or use the technology.

Lefever in his conclusions states

"The idea of Receptivity described the technical, organisational, cultural and personal issues and processes which determine how technology will be received within the recipient organisation. The concept of organisational Receptivity to any form of change, but particularly technological change has been shown by other authors to be the critical element in both the level and success of technology transfer." (Lefever, 1992).

Another term used in the literature to convey similar meaning is that of Absorptive Capacity (Cohen & Levinthal, 1990). They present the following argument

"... we argue that the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities. We label this capability a firm's absorptive capacity and suggest that it is largely a function of the firms level of prior related knowledge" (Cohen W., Levinthal D., 1990)

The terms 'Receptivity' and 'Absorptive Capacity' are conceptually similar, with the ability to recognise the value of new external information (about

technology in the case of technology transfer), the ability to assimilate the information, and then to apply it (acquire and deploy technology in the case of technology transfer) as common elements in both concepts.

CHAPTER 3

3. REVIEW OF KEY CONCEPTS AND RELEVANT LITERATURE

The need to improve economic growth has become a re-occuring concern of governments. Any downswing in economic activity prompts efforts to find ways to improve economic performance. Research work seeking to identify means of encouraging industrial innovation, or cultivating application of new technology has therefore found support, and as a result quite a large literature dealing with both innovation and technology transfer is evolving. This review seeks to identify from this literature certain key concepts and themes of specific relevance to this research.

3.1 THE DETERMINISTIC INDIVIDUALISTIC DEBATE

The wide ranging debate in the social sciences concerning the relationship between human beings and their environment has had an important impact within innovation and technology transfer literature. Burrell and Morgan set out the theoretical position.

"Thus we can identify perspectives in social science which entail a view of human beings responding in a mechanistic or even deterministic fashion to the situations encountered in their external world. This view tends to be one in which human beings and their experiences are regarded as products of their environment; one in which humans are conditioned by their external circumstances. This extreme perspective can be contrasted with one which attributes to human beings a much more creative role: with a perspective where free will occupies the centre of the stage; where man is regarded as creator of his environment" (Burrell and Morgan,1979)

Kelly (1978) attempted to categorise the classical theories of innovation and found that they polarised around the two positions: deterministic and individualistic. Deterministic theories holding that innovation occurs when the appropriate combination of social forces create the right environmental conditions, whereas individualistic theories stress the creative role of the individual.

Kelly concludes that

"These two major theses are not mutually exclusive; they are a matter of emphasis. No scholar has ever claimed that the individual inventor runs his own race entirely unbridled by external pressures, and even the most ardent adherent of the deterministic school has recognised that the manifold and diverse forces operate through individuals. This accounts for the development

of sophisticated, composite theories, embodying elements of both deterministic and individualistic schools of thought." (Kelly et al, 1978)

Similarly the debate continues in the technology transfer literature where researchers (Rothwell and Beesley, 1989) debate the relative importance of environmental and infrastructural factors as opposed to individual and other factors internal to SMEs.

Conceptually the process of technology transfer can be seen, from a deterministic point of view, as a process largely determined by social, environmental and economic forces external to an SME. Alternatively, from an individualistic viewpoint it is the characteristics, qualities and actions of the individuals within the SME that are important.

Operationally these conceptualisations lead to policy favouring creation of appropriate social, environmental and economic conditions, or alternatively, policy concerned with influencing and developing the attitudes, qualities and other individually rooted characteristics within SMEs. For example Rothwell and Beesley (1989), following their research, recommend public policy initiatives to provide training for SME managers in technology strategy and management.

3.2 THE PUSH PULL DEBATE

One of the re-occuring topics in the literature of technological innovation (and technology transfer) is the debate about the relative importance of 'technology push' determined activity, in contrast with 'demand pull'. Freeman (1982) explains the position for innovation

"Innovation is essentially a two sided or coupling activity. It has been compared by Smookler (1966) to the blades of a pair of scissors, although he himself concentrated almost entirely on one blade. On the one hand it involves the recognition of a need or more precisely, in economic terms, a potential market for a new product or process. On the other hand it involves technical knowledge, which may be generally available, but may also often include new scientific and technological information, the result of original research activity. Experimental development and design, trial production and marketing involve a process of matching the technical possibilities and the market. The professionalisation of industrial R&D represents an institutional response to the complex problem of organising this 'matching' but it remains a groping, searching, uncertain process.
In the literature of innovation there are attempts to build a theory predominantly on one or other of these two aspects. Some scientists have stressed very strongly the element of original research and invention, and have tended to neglect or belittle the market. Economists have often stressed most

strongly the demand side: 'necessity is the mother of invention'. These one sided approaches may be designated briefly as 'science push' theories of innovation and 'demand pull' theories of innovation." (he cites Langrish et al 1972)

The influence of this debate has also had impact on conceptual frameworks adopted for the technology transfer process. For example one of the early models developed was that termed by Williams and Gibson (1990) the 'Appropriability' model. Here it was assumed that deliberate technology transfer mechanisms were unnecessary and the quality of the technology was the key factor determining technology transfer 'Invent a better mousetrap and the world will beat a path to your door'. This early model can be seen as rooted in the technology push side of the debate.

The conceptualisation of the process of technology transfer has also had impact on operationalisation. The concentration by technology transfer intermediaries on facilitating access to technology, and to technology related information, can be seen as an example. There is an assumption behind these types of activity that exposure to technology or technology related information will, in itself, lead to technology transfer. Once the 'better mousetrap' has been seen, the world (including SMEs) will beat a path to the door of the technology.

It is, however, interesting to note at this point that technology transfer intermediaries have used both technology push and demand pull approaches with SMEs without success (a point that will be returned to again in the last chapter of this thesis). Typically technology push activities have consisted of the construction of databases or listing of technologies for license or transfer. Intermediaries have then used these catalogues as a means of marketing technology to potential consumers or users. Demand pull activities have focused on the potential user or consumer and have been typified by the survey or interrogative interview in order to 'discover' technology requirements 'from the marketplace'. The findings of these surveys are seen as representing the market 'demand' and then used for seeking out technology to meet this market demand.

Freeman examines both technology push and demand pull approaches and finds evidence that it is not difficult to cite examples which give support to either theory. Freeman, however, finally comes to the conclusion that

"Whilst there are instances in which one or the other may appear to predominate the evidence... points to the conclusion that any satisfactory theory must simultaneously take into account both elements. Since technical innovation is defined by economists as the first commercial application or production of a new process or product, it follows that the crucial contribution of the entrepreneur is to link the novel ideas and the market. At the one

extreme there may be cases where the only novelty lies in the idea for a new market for an existing product, at the other extreme there may be cases where a new scientific discovery automatically commands a market without any further adaptation or development. The vast majority or innovations lie somewhere between these two extremes, and involve some imaginative combination of new technical possibilities and market possibilities. Necessity may be the mother of innovation, but procreation still requires a partner" (Freeman, 1982)

3.3 DIFFUSION

The relationship between technology transfer and diffusion has been mentioned earlier in this thesis. Researchers tend to distinguish two modes of technology transfer - point to point (Rubenstein, 1989) and diffusion.

The seminal work of Everett Rodgers (1983) pervades much of the literature on diffusion and this thesis considers that his findings have particular relevance to the issue of Receptivity. Many of Rogers' findings, and in particular his findings about the factors leading to the success of 'change agents', point to the importance of a client centred approach.

Rogers considers a 'change agent' to be an individual who influences client's decisions in a direction deemed desirable by a change agency. The ERTC can be seen as being a change agency and the individual field officers the equivalent of Rogers' change agents.

Rogers identifies seven roles for the change agent:

1) to develop a need for change on the part of clients
2) to establish an information exchange relationship
3) to diagnose their problems
4) to create intent to change in the clients
5) to translate this intent into action
6) to stabilise adoption and prevent discontinuities
7) to achieve a terminal relationship with clients

The roles Rogers proposes for the change agent are client (or consumer) oriented, and it will be argued later in this thesis that the development of need for change on the part of clients, the diagnosis of their problems, and the creation of intent to change in clients, could all be considered as activities leading to increased consumer Receptivity. Key to the concept of Receptivity are a consumers ability to 'see' the need for change and to be able to articulate their need to some attainable solution.

Rogers then examines research evidence in order to determine the factors that had been found as leading to the relative success of change agents in securing adoption of innovations by clients. He concludes that relative success is positively related to:

1) The extent of change agent effort in contacting clients
2) A client-orientation rather than a change agent agency-orientation
3) The degree to which the diffusion program is compatible with clients needs
4) The change agents empathy with clients
5) His or her homophily with clients
6) Credibility in clients eyes
7) The extent to which he or she works through opinion leaders
8) Increasing clients' ability to evaluate innovations

The factors that Rogers distils from the research as leading to relative success of change agents also turn out to be heavily consumer oriented (with even client-orientation specifically identified as one of the factors). It was of great puzzlement to the author that during a discussion of Rogers' findings with one of the RTCs the comment was made that these finding only seemed 'common sense' and therefore could be largely ignored. Although some of the findings may appear common sense it would seem to be no straightforward matter to implement action to achieve them. What, for example, confers credibility in clients eyes, and how could empathy with clients be stimulated. These are again matters returned to later in this thesis.

Rogers continues his individualistic client oriented approach when considering the characteristics of innovations which explain their different rates of adoption. He concludes that it is the characteristics of innovations, as they are perceived by individuals, that explain their different rates of adoption. He details the following:

1) Relative advantage - the degree to which an innovation is perceived as better than the idea it supersedes.
2) Compatibility - the degree to which an innovation is perceived as being consistent with the existing values, past experiences and needs of potential adopters.
3) Complexity - the degree to which an innovation is perceived as difficult to understand and use.
4) Trialability - the degree to which an innovation may be experimented with on a limited basis.
5) Observability - the degree to which the results of an innovation are visible to others.

Thus Rogers sees the perception of the individual as the key determinant of adoption of innovations.

"It does not matter so much whether an innovation has a great deal of 'objective' advantage. What does matter is whether an individual perceives the innovation as advantageous" (Rogers, 1983)

3.4 CONTINGENCY THEORY

The approaches to technology transfer described in the first three sections of this chapter have been criticised as being in the tradition of proposing Grand Theories leading to models of universal application. An alternative consideration is that, for any particular instance, organisation, and set of social, environmental and other circumstances, there may a particular combination of factors determining the success or failure of technology transfer initiatives. This type of theory leads away from models of universal application toward contingency models where a large number of factors need to be considered in respect of their influence on each other, and on the individual instance and context under consideration.

3.5 FACTORS INFLUENCING TECHNOLOGY TRANSFER

There has been particular interest in factors which have been observed or found, empirically to be influencing the process of technology transfer.

Godkin (1988) in his review of the relatively large amount of literature dealing with the problems and practicalities of technology transfer, classifies influencing factors into factors fostering technology transfer, and factors hindering transfer. On the positive side he identifies several factors which he considers dominate the literature. These are:

1. Management support
The support of management would seem to be primary in ensuring the success of the technology transfer process. (Hertz, 1965)

2. Appropriate legislation
Legislative measures can positively influence the technology transfer process. (Brody, 1985 McDermott 1985)

3.Brokering systems
The establishment of decentralised third party brokering systems to actively assist targeted user groups can assist in house technical staffs in technology transfer activity. (Meima et al, 1984)

4. Participation by higher education

Interaction with Higher Education Institutions (HEIs) is seen as beneficial. On campus, university related science parks are cited as a successful mechanism in fostering local companies. (Rogers and Shoemaker, 1971)

He also identifies in the literature a number of studies which support Lefever's conclusions that there was need for a more consumer need centred and interactive approach to technology transfer. In considering other factors which foster technology transfer Godkin cites Lingwood (1975) and Roberts and Frohman (1978) indicating the positive nature of arriving at a clear understanding of the needs, perceived and real, of the user. Other positive factors identified in the literature by Godkin include:
Perception of need by the recipient (Langrish et al 1972)
Need recognition (demand pull) (Utterback, 1974)
Source anticipation of user requirements (Jervis, 1978)
Characteristics of the recipient organisation (Carter and Williams, 1959)

On the negative side Godkin considers the literature to identify a number of factors he considers "to influence negatively the process of technology transfer". These are:

1. Literature and research
Technology transfer can be considered to be in a nascent phase of development and Godkin points to defects in research, analysis of research and the body of existing literature.

2. Contextual fit
The question of contextual fit, or source-recipient incompatibility is a primary issue. Godkin cites, as an example, the work of Sharif and Haq (1980) which concluded that if the technological difference between source and recipient is too great, then the technology is too complex to transfer

3. Research teams
Technology transfer suffers when research teams are not interdisciplinary in nature (Lingwood, 1975)

4. Information storage and retrieval
Limitations in the ability to process relevant information may present barriers to technology transfer. (Bradbury et al, 1978)

5. Decision making
Poor management decision making ability will inhibit technology transfer.

6. Competition
Transfer may be inhibited by individual or organisational competition. (Essoglou, 1985)

7. Compensation systems
Organisational initiatives designed to encourage applications may not be rewarded. (Essoglou, 1985)

8. Proximity
Geographical distance impedes technology transfer. (Roberts and Frohman, 1978)

Among the other factors that Godkin notes in the literature as hindering technology transfer are that industry often lacks the will or ability to specify the nature and appropriateness of research (Monrone and Irvins, 1982) and also unfamiliarity with client needs (Lingwood, 1975).

3.6 TECHNOLOGY TRANSFER TO SMEs

Of particular concern to this thesis are previous studies specifically concerned with technology transfer to SMEs and the role of SMEs in the process of innovation.

Rothwell and Zegvelt (1982) examined innovation in SMEs and came to the conclusion that particular characteristics of SMEs gave them particular advantages and disadvantages in their role within the innovation process. Although this particular study was examining SMEs as innovation producing (rather that consuming) units, some of the findings of their work is of particular interest within this thesis. They identify particular weaknesses within SMEs which also have implications for the ability of SMEs to consume technology or respond to technology transfer initiatives. The characteristics of interest to this thesis that they identify are:

1) Manpower - SMEs only have limited ability to employ QSEs (Qualified Scientists and Engineers). For Rothwell and Zegvelt, concerned about the production of innovation, this had implications for SME's ability to perform competitive Research and Development, or their ability to design for marketability. However from the technology transfer perspective this same weakness would affect an SME's ability to understand new technical developments and their implications or relevance to the SME. It would also have relevance to the SME's ability to be able to use or effectively deploy new technology even after its relevance had been recognised.

2) External communications - SME's time and resource commitments to information processing and external communications are again limited. Again

from the technology transfer perspective this limits the information base from which SMEs are able to scan and select technology . An additional related point is made with respect to SME's information processing abilities is that SMEs find difficulty in keeping abreast of the plethora of government measures to assist them. Rothwell and Zegvelt cite previous studies (Rubenstein, 1977) indicating that small firms in the UK were largely unaware of the range of policy measures open to them. They conclude

"Clearly the implications for government of this conclusion is that they should adopt a very much more positive stance towards the dissemination of information describing available innovation assistance for small firms" (Rothwell and Zegvelt, 1982)

3) Management techniques and practice - SMEs are often headed by an all powerful autocrat whose capabilities determine the firms activities and plans. This can lead, in the cases of SMEs, with an inappropriately skilled owner, to an inability to formulate business strategy and make appropriate plans for the future. This is seen as a particular problem.

"Even in SMEs possessing democratic, consultative managers, problems can exist because of their lack of management expertise. This often manifests itself in an inability to plan properly for the future. In a time of accelerated technical, social and economic change, the formulation of a corporate strategy, and of plans to implement such a strategy, is essential. This is a particularly weak point in SMEs." (Rothwell and Zegvelt, 1982)

4) Finance - SMEs have particular difficulty in raising finance for risk projects. The cost, risk and difficulty in raising finance can all be seen as disincentives for adopting new technology.

These findings are discussed and specifically related to technology transfer in a later study. Rothwell and Beesley (1989) attempted to answer the question about whether lack of access to external technological know-how and expertise was a barrier to growth in small manufacturing firms (SMFs). They conclude

"We have been unable to obtain any evidence to suggest that lack of access to external technology and know-how is a significant barrier to growth in SMFs that have growth potential"

They then address the question of infrastructural deficiencies in the UK in relation to technology transfer. Their findings clearly have implications for technology transfer activity

"There was no evidence in the material surveyed to suggest that there are infrastructural deficiencies in the UK that particularly inhibit SMF's access to

external technology and technical expertise. The most important factors determining an SMF's propensity and ability to access external sources of technology are internal to the firm, most notably the employment of QSEs (Qualified Scientists and Engineers) and the outward-lookingness of management" (Rothwell and Beesley, 1989)

If these findings are applicable to SMEs in general then a question mark must hang over additional measures, in terms of technology transfer provision or infrastructure, which are largely concerned with access to external technology and technical expertise. If, indeed, access to external technology and expertise is not a barrier to SMEs, then it is not access to technology which should be addressed, but the internal factors which determine the SME's propensity and ability to access external sources of technology. Rothwell and Beesley conclude their study with two recommendations on public policy initiatives which they consider may go some way toward overcoming the internal deficiencies that they had identified.
1. Subsidies to support the costs of employing technical specialists.
2. Training courses for SMF managers in the general area of technology strategy and management.

The Rothwell and Beesley paper formed part of a larger study of barriers to growth in small companies, commissioned by ACARD (The Advisory Council for Applied Research and Development) and the Department of Trade and Industry. The findings of that study have been summarised by Barber, Metcalfe and Porteous (1989) and although only a section of the study specifically concerned technology transfer it is appropriate to review certain other of the findings, of particular interest to this thesis. Many of the findings re-inforce and supplement the findings of the earlier Rothwell and Zegvelt (1983) study. They are summarised by Barber et al under three headings:

1. Management and Motivation
Examination of available literature about the management of small businesses indicates

"a consistent picture of lack of managerial training, relatively low qualifications and poor competence" (Barber et al, 1989)

and they see this as contributing to the fact that the attitudes of UK managers towards technological change and innovation can be taken to be a poor reflection of those in major competitor countries.

"Small-business owners lack the evaluation skills necessary for costing technological change.... Fear of new systems stems, in part, from an inadequate knowledge of complex new technology and this hinders investment decisions" (Bosworth and Jacobs in Barber et al, 1989)

The literature also points to owner-managers attempting to keep control of key decision making, and other important aspects of the business, rather than delegating responsibilities (see selection of research sample - Chapter 5). As a result the limitations of the owner-managers abilities often provide the important limiting factors for the small business. Barber et al also conclude that the allocation of scarce resources - financial, technical or human - is a strategic issue which is often poorly understood by managers of small firms.

2. Resources

Access to finance is often cited as a key constraint on growth of small firms and more generally on innovation, and as will be seen later in this thesis, was seen by SMEs as a key element in the solution of problems and the achievement of plans. There is, of course, nothing remarkable in this statement, most business problems can be solved and most plans achieved by the availability of large amounts of finance. The real problems for SMEs are the terms and conditions upon which finance is made available to them, with many SMEs considering them to be unacceptable, given the potential balance between risk and return.

"Finance is typically supplied in a package with potential lenders and borrowers often having quite different needs in terms of elements of risk, security and repayment of principal implicit in the package. For companies basing their growth on the development of new technology, the potential for divergent assessment of risks, for example, is obviously considerable. Thus the question is not the availability of funds per se but availability at a price and conditions on which borrower and lender can agree." (Barber et al, 1989)

Attracting and retaining skilled or qualified labour was another resource problem area, another barrier to growth, identified for small firms by the ACARD study. Of particular concern is the effects on the SME's ability to cope with technical change.

"The ability to adopt, adapt and assimilate technical and organisational innovations depends on the quality of both the entrepreneur and the workforce. The crucial role of investments in labour force competence are now beginning to become clear from the empirical literature. However, small firms are least able/least willing to attract high quality personnel although there is a tendency for the small-business owner-manager to under estimate the quality of his existing workforce" (Bosworth D. in Barber et al, 1989)

One of the problems to be addressed later in this thesis is that of deciding whether a problem or plan concerning the acquisition of appropriately skilled labour is, in effect, a technology transfer problem or plan. In the spirit of our earlier definitions, technology transfer is as much about transfer of information as about transfer of artefacts.

3) Market Opportunities and Structures
The ACARD study identifies two sets of factors influencing the success of small firms. The first is the market structure within which the firm operates and the study cites characteristics such as market growth, size and frequency of purchase and degree of market segmentation. The second set of factors concern the activities of large firms and the opportunities available to small firms to collaborate or to merge. Both collaboration and merger can be seen by both small and large firms as another strategy for acquisition of technology. Again to what extent is a plan for a joint venture to be classified as a strategy for technology transfer ?
Finally the conclusions of the study on marketing opportunities and structures are of both interest and relevance.

"The weight of evidence on market structure and the competitive positioning of small firms suggests that the really systematic and pervasive problems faced by small firms are internal to the firm, such as the technical skill base, the management systems and processes, appropriate organisational structures and the availability of skilled managers. In terms of positioning the firm against the market, small firms are specially handicapped by their limited resources and the restricted range of assets they have available" (McGee J. in Barber et al, 1989)

3.7 FOCUS ON CUSTOMER (DEMAND) CENTRED TECHNOLOGY TRANSFER

A customer centred focus is not new within innovation and technology transfer literature. In the SAPPHO project conducted at SPRU it was argued that understanding user's needs was the most critical factor for successful innovation (Rothwell, 1974). Von Hippel (1988) had also identified industrial customers as a source for innovation in industrial goods and proposed a customer oriented approach to innovation.

However recently an increasing number of publications have been shifting attention away from the traditional emphasis on creation of new technologies (supply of technology) to focus on the abilities of companies to absorb or adapt technology. Lewis Branscomb, former IBM Chief Scientist, in a recent article about American Technology Policy, argues

"in a competitive environment characterised by nonstop innovation, simply creating new technologies - whether military or civilian - and funding basic research in universities are no longer good enough" (Branscombe, 1992)

A new emphasis, he contends, is required.

"Increasingly competitive success goes to those companies that can absorb and apply new innovations quickly - no matter where they have originated.
There is an important role for government technology policy in this process, but it is not the one that most supporters of technology policy think. Instead of concentrating on the 'supply' of new technologies, government should stimulate 'demand' " (Branscombe, 1992)

Similarly Fumeo Kodama (1991), former research director of Japans National Institute for Scientific and Technology Policy, agrees that successful companies are now not necessarily those that create new technologies but those that rapidly absorb them. As a result he proposes

"In the high-tech era, the key issue of technology policy has become not how to break through technological bottlenecks, but on how to put existing technology to best use. Accordingly, a day of reckoning has come for technology policy, which traditionally has emphasised the supply side of technology development. A need has now arisen for a technology policy which works from the demand side." (Kodama, 1991)

He goes on to suggest that a company's capacity to absorb and adapt technology is increasingly becoming the key to business strategy. This requires an organisational capacity to spot promising new technologies and quickly incorporate them into new products and processes. Kodama suggests that, to do this effectively, companies have to develop the ability to fashion a technology investment strategy - to enable them to articulate demand.

3.8 MARKETING OF HIGH TECHNOLOGY

Strangely technology transfer and commercial marketing of technology are often not linked or seen as similar or complementary activities. Literature dealing with technology transfer often only has a brief (if any) mention of commercial marketing of technology and yet the purchase of technology from commercial vendors is clearly one of the major ways in which SMEs acquire their technology. The objective of increasing technology transfer to SMEs, it can be argued, can be seen as a comparable activity to that of persuading an SME to acquire technology by purchase.

The key point of interest for this thesis is that literature dealing with marketing of technology, has for a long time been focusing heavily on an interactive customer-oriented approach to marketing high technology. Dr W. Davidow, former senior vice president of sales and marketing for Intel (USA's largest semiconductor manufacturer) provides the following points:

"Customers needs and desires define products. As they change so must the product. Evolving customers demand evolving products"
"For most products, good promotions begin with marketing people succinctly expressing the benefits a product will bestow on a distinct market. While that discipline is common in consumer marketing people it is frequently overlooked in high-tech. Possibly that results from lack of training, but more likely it is inherent in the technological orientation of the companies. Too many think of their businesses in terms of the devices they manufacture rather than the benefits those products provide to customers" (Davidow, 1986)

Selling customer benefits rather than the technical specification of devices is one of the re-occuring themes of literature covering successful high-tech marketing. The requirement for an interactive dialogue with customers to understand their needs, and to ascertain that the product confers the required benefits, is normally identified as a prerequisite.

"In order to be effective, marketing people must always be probing for information and building close relationships with customers. The marketing groups that are really in touch with the customer not only can quote reams of data about the market but can also talk very specifically about the personality of the customer base. The will know customers by name and will be able to discuss their specific problems. They will be able to overwhelm you with examples. Important customers, key salespeople and distributors will seek those marketing people out and will keep them informed about what is going on" (Davidow, 1986)

It seems strange that, in the world of technology transfer, the lessons learnt in marketing of high-technology seem to be considered irrelevant. Impersonal, information dissemination about technology is often the approach of technology transfer intermediaries. 'Devices' rather than customer benefits would seem to be the order of the day !

3.9 CONCEPTUAL FRAMEWORKS FOR TECHNOLOGY TRANSFER

3.9.1 BACKGROUND

Concepts are employed to permit the imposition of meaning on the world that we perceive. They provide a link between a word (or words) and an ordered relationship between a range of variables. The variables are given meaning by the concepts employed to link them together. In turn the way that we perceive the world, and subsequently act, becomes dependent on the concepts we use. As the range of concepts employed to impose meaning on phenomena changes so does the perception of the phenomena. Research into technology transfer has established a wide range of linked variables, and various constructions of meaning have been imposed by the development of conceptual frameworks.

Action (policy) is closely linked to these available ways of 'seeing' the 'reality' of technology transfer.

There have been a number of approaches in the literature to developing conceptual frameworks, or deriving models, for the technology transfer process.

Williams and Gibson (1990) provide an overview by examining the literature and distinguishing four models of the technology transfer process.

The earliest (1945-50s) they term 'The Appropriability Model' and they suggest that this model

"emphasises the importance of the quality of research and competitive market pressures to promote the use of research findings"

this technology push rooted model envisages that competitive market pressures will constantly force the search for new or improved technology. Policy designed to maximise the development of new technology and the flow of information about the technology relates to this type of model.

"Deliberate transfer mechanisms are viewed as unnecessary; all the researcher need to do is to develop the right idea (e.g. develop a better mousetrap) and the customer will beat a path to the inventor's door. Good technologies, according to this model, sell themselves" (Williams F., Gibson D., 1990)

Then, citing the work of Rogers and Kincaid (1981), they propose a second model which they term 'The Dissemination Model (1960-1970s)'. They consider it to emphasise the diffusion of innovations where experts inform potential users of the technology.

"The objective is to transfer expert knowledge to the user who is a willing receptor. Once linkages are established, the new technology will flow from the expert to the non-expert much like water through a pipe once the channel is opened." (Williams F., Gibson D., 1990)

If one accepts that the 'Dissemination Model' takes in diffusion of innovation theory then their summary of the characteristics of the model can be criticised. One of the main consequences of diffusion theory was to shift the focus of attention from the producers of technology to the consumers. Williams and Gibsons' identification of users as willing receptors would seem to overlook the considerable emphasis in diffusion theory on meeting needs of users. Users are seen as willing receptors providing the innovations meet their needs. Diffusion theory has been strongly linked with consumer-needs oriented marketing and the ascendancy of demand pull influenced policy in the 1980s.

These two earlier models can be seen as very broadly conforming to the technology push and demand pull positions within the 'push-pull debate' discussed in the previous chapter. Williams and Gibson see these earlier models as now being superseded by what they term the 'The Knowledge Utilisation Model' which they see as beginning to acknowledge the complexities of the technology transfer process. This model

"emphasises the importance of interpersonal communication between technology researchers and clients, and also identifies the organisational barriers or facilitators of technology transfer"

The development of this type of model can be seen as a reflection of the view that both technology push and demand pull factors have to be considered in conjunction with individual and organisational influences. Clearly a much more complex model! In addition the emphasis on interpersonal communication implies an interactive approach however Williams and Gibson consider this model still to suffer from a linear bias.

"it suffers from an inherent linear bias (they cite Dimancescu and Botkin, 1986). The stated or implicit notion is that basic research moves from researcher to client, in one direction, to become a developed idea or product. This model tends to reduce the transfer process to chronologically ordered one-way stages, whereas practice shows the process to be interactive and complex."

Finally Williams and Gibson go on to identify a new fourth model which they term a 'communications-based model'. They consider it has several distinguishing characteristics

"Successful technology transfer is an ongoing, interactive process where individuals exchange ideas simultaneously and continuously. Feedback is so pervasive that the participants in the technology transfer process can be viewed as 'transceivers' thereby blurring the distinction between the source(s) and destination(s)."

" Transferred technology is the result of an unplanned mixture of energy (participants), solutions looking for problems, choice opportunities, and problems looking for solutions. The model is not unidirectional. Feedback helps participants reach convergence about important dimensions of the technology. Both problems looking for solutions (technology pull) and technology solutions looking for problems (technology push) are encountered." (Williams F, Gibson D, 1990)

3.9.2 THE AMR CONCEPTUAL FRAMEWORK

The deficiencies in earlier conceptual frameworks have also been addressed by Lefever (1992) Seaton and Cordey-Hayes (1993). They also propose a conceptual framework which accepts the complexity and interactive nature of the technology transfer process.

Lefever in considering the role of intermediaries in technology transfer views the technology transfer process as a source (e.g. a company, university, R&D unit) offering technology to a recipient (e.g. company, manufacturing unit) via some means (e.g. via a technology transfer intermediary in Lefevers case). In its most elemental form this view can be reduced to a source of technology, making available technology, through some channel or communications process, to a recipient. Conceptually three elements are identified, a Source, a Channel and a Recipient with technology transfer being seen as the process by which technology moves from sources via channels to recipients. This is in line with other writers - Rogers (1983), for example, explains the crucial elements of diffusion of innovations as 1) the innovation (Source element) 2) which is communicated through certain channels (Channel element) 3) among members of a social system (Recipient element). Rogers however identifies a fourth element, that of time - the process occurs over time.

Lefever then considers attributes of the identified elements. The Source provides access to technology, the Channel mobilises, communicates, or makes the technology available, and the recipient absorbs or deploys the technology. Lefever then moves to consider a conceptual framework based on these attributes which he terms AMR (Accessibility, Mobility and Receptivity).

Accessibility is explained as being fundamentally access to knowledge, and not just implying a sense of physical access to sources of technology. Mobility is seen as being essentially the mechanisms and channels by which technology is transferred.

"The mechanisms of transfer are the ways in which the information is actually imparted, whether this be by the exchange of literature, a physical movement of a person from one organisation to another, by a joint venture or by a technical consultancy" (Lefever, 1992)

Finally the term Receptivity is used to refer to the overall capability of recipient organisations to assimilate and to use the technology.

Lefever summarises the AMR framework

"The three elements are:

Accessibility - the technologies available and information about those technologies.

Mobility - the ease of movement of those technologies and the channels by which movement is secured.

Receptivity - the awareness of technology within the organisation, the willingness to investigate technology and the ability to assimilate technology in the recipient organisation.

CHAPTER 4

4. DESIGN OF THE FIELD INVESTIGATION

4.1 BACKGROUND

The earlier research conducted by INTA at Cranfield (Lefever 1992) had identified a mismatch between the services provided by agencies and the requirements of their target markets. Lefever argued that the widely used approach of the agencies of maximising access to information about technology was insufficient for technology transfer to spontaneously occur. The AMR framework, and the role of technology transfer intermediaries, had been examined by Lefever and he had concluded that

"Too much emphasis has been placed on raising the general level of Accessibility to industry of technology with insufficient effort placed on raising the Receptivity of industry ...."

Lefever's propositions seemed to be borne out in practice in that many of the activities of the ERTC and other technology transfer agencies were indeed focusing on dissemination of information (making technology Accessible) and these current activities were having little success with SMEs.

It was therefore resolved to conduct a field investigation to explore the concept of Receptivity with respect to SMEs in the hope that it would shed some light on effective strategies or mechanisms to facilitate technology transfer to SMEs.

4.2 DEVELOPMENT OF FIELD RESEARCH - PHASE 1

The early design of the field investigation evolved as part of an interactive series of meetings between the author and an advisory panel. In between meetings of the panel certain investigatory activities were carried out, and the results considered at the next panel meeting, and the research design modified accordingly. The first portion of this chapter consists of narrative describing the evolution of the design

Previous research conducted at INTA and findings from the literature survey seemed to indicate that increasing access to external technology and technical expertise, and provision of access related services, would not, by itself, be sufficient to lead to an increase in technology transfer to SMEs. This also seemed to be what was occurring in practice, with technology transfer intermediaries concentrating on Accessibility strategies, and having little or no success in increasing technology transfer to SMEs. The AMR conceptual framework proposed by INTA and developed by Lefever, in conjunction with findings from the literature search were focusing in on the ability of companies

companies to consume technology and specifically on the concept of their 'Receptivity' to the technology transfer process.

It was therefore decided that initial exploratory informal discussions should take place with local SMEs with a view to seeking some pointers as to why SMEs did not participate in technology transfer activities or make use of the services of the RTC - why, in fact, they were unreceptive to external technology transfer.

These exploratory meetings consisted of a normal visit to an SME with the researcher in the role of Manager of the Bedfordshire office of the ERTC. A selection of the ERTC literature (see Appendix A) was taken and the meeting consisted of a short presentation on the activities of the ERTC followed by a discussion about how the ERTC may be of assistance.

The feedback from these informal discussions provided a confusing picture in that the companies visited seemed to appreciate the importance of technology to their businesses. In discussion the companies would invariably agree that technology was, and would be, of importance to their business, and general propositions about the need to use latest technology to remain competitive, seemed to be readily accepted. However when it was suggested that the SMEs should consider examining some of the technology transfer options, or using the services of the ERTC they often declined. The companies who did examine some of the options, almost without exception, lost interest over a period of time as information or proposals were presented to them.

There were, of course, a number of possible explanations for this outcome. The companies may be convinced about the need to use latest technology but have not liked the author's presentation of the case or subsequent material. Alternatively, although it was stressed that the services of the ERTC were free, there is a strong feeling among SMEs that 'there is no such thing as a free lunch' and there may have been the suspicion that ultimately they would be charged or penalised in some way for using ERTC services.

However it was felt that neither of these explanations offered a satisfactory solution. Given that low success with SMEs was generic to the RTC movement and technology transfer intermediaries as a whole the individual element could be discounted. There were a wide variety of approaches being adopted and many different types of people involved. The fear of being charged or penalised certainly could not be discarded but if SMEs were convinced of the need to use best technology it did not seem reasonable to assume that this would act as a universal deterrent.

The investigation, to this stage had merely served to confirm the paradox stemming from the Hausner study and other investigations (referred to later as

the Hausner Paradox). SMEs, in response to questions about technology and technology transfer, state that they appreciate its importance and the need for the provision of a range of technology transfer services. Then when the SMEs have the opportunity to participate in the technology transfer process, or to make use of technology transfer services they fail to do so.

The focus of attention of the investigation then shifted to the problems and plans of the SMEs. In the informal discussions with SMEs there was frequent linking between acquisition of technology and problems and plans of the SMEs. Statements such as
"We bought the adhesive machine because the quality (of manually applied adhesive) needed to be improved"
" One of our engineers is learning Autocad on day release"
indicated that SMEs were making this type of linkage. In the first instance the company acquired the machine because it solved their quality problem and in the second they were planning to use CAD and needed to obtain the necessary internal skills to bring the plan to fruition. It seemed reasonable to assume that an SME would have to perceive some utility in a technology before acquisition - the technology would have to be seen as solving some problem or facilitating the attainment of some plan. It also seemed reasonable to assume that the 'Receptivity' of the SME may in some way relate to the extent that they were able to perceive acquisition of technology as a solution to their problems, or as a means to achieve their plans. It followed that an understanding of problems and plans may assist the investigation and shed some light on any link between problems and plans and the concept of Receptivity.

Initial exploration of the SMEs immediate problems started to bear fruit in that examination often revealed problems with what seemed to be an implicit rather than an explicit link to technology. For example, a common problem identified by SMEs (in mid 1991) was that of generally declining sales due to the recession. In order for the business to remain profitable the SME had to take some action and a number of strategies were possible. Redundancies (cutting labour cost) and increased marketing effort (capture a larger share of the declining market) were the two strategies explicitly identified however improving product or process technology was also a valid (but not explicitly identified) strategy (to cut costs and/or to increase market share). This suggested an initial proposition that SMEs may find it difficult to identify technology as a valid option in the solution of problems or the achievement of plans. The SMEs seemed to have problems and plans where any link to technology needed to be made explicit before it could be considered as a valid solution to problems or a route to achieve business plans.

Three research questions emerged:

1. Do SMEs find it difficult to identify technology as a valid option, in the solution of problems, or the attainment of plans ?

2. If so is it because the technology options are implicit (i.e. technology based solutions or routes exist as a valid options, but the SME is unaware of them) ?

3. If technology options are implicit how could they be made explicit ? Is this a role for technology transfer intermediaries?

4.3 DEVELOPMENT OF PHASE 2

It was decided that an initial formal investigation should seek to shed light on these questions through the development of an understanding of the problems and plans of SMEs and their perception of solutions to problems, or routes to achieve plans.

4.3.1 CONSTRAINTS ON FIELD WORK

A couple of constraints on the field research were recognised:

TIME - the research had to be completed within the time constraints of a Part Time M.Phil. It was anticipated that at maximum the equivalent of between two and three weeks full time effort could be spent on actually carrying out the field research.

LOCATION - any in-depth work with SMEs would have to be conducted locally.

4.3.2 SELECTION OF RESEARCH TECHNIQUE

The objective of the second part of the investigation was to investigate the extent to which SMEs find it difficult to identify technology as a valid solution to problems, or as a means to achieve plans.

In order to carry out the investigation it was necessary to select an appropriate research method that would enable the elicitation of the problems and plans of an SME, as they were perceived by the SME, and then once these were established, would also permit investigation into whether the SME perceived technology as a valid option for solutions to problems or routes to achieve plans.

There were two types of consideration made in the establishment of an appropriate research technique. The first were practical considerations about

the nature of a technique that would be appropriate for the investigation. The second set of considerations related to rooting appropriate techniques within relevant theory and dealing with the critical theoretical and moral issues.

On a practical level there were three main considerations:

1. Data collected by both Hausner and the RTCs by quantitative social survey type techniques were leading to confusing results. SMEs were responding positively to questionnaires about technology transfer and provision of services by technology transfer intermediaries, but then in practice making no use of the services once they were provided. These quantitative approaches seemed to be leading to misleading conclusions. A more detailed, in depth investigation seemed to be required.

2. It was felt that the elicitation of 'real' problems and plans from an SME would be best accomplished by some form of personal meeting or interview. In particular it was anticipated that SMEs would respond poorly, or could easily misinterpret, impersonal requests to disclose details of their problems or plans for their business.

"Some social scientific questions elicit easy and rapid responses from the respondent. The respondent can identify precisely what is wanted, retrieve it easily, and report it without ambiguity. Other questions are much more demanding. The respondent has more difficulty determining what is wanted. He or she must labour to identify and articulate a response. The difference between reporting abilities is, effectively, one of the differences between qualitative and quantitative methods. When the questions for which data are sought allow the respondent to respond readily and unambiguously, closed questions and quantitative methods are indicated. When the questions for which data are sought are likely to cause the respondent greater difficulty and imprecision, the broader more flexible net provided by qualitative techniques is appropriate" (McCracken, 1988)

3. Finally there was concern about the bias that could be introduced into any interview as a result of the perception of the interviewer by the interviewee. If the interviewer was introduced as a representative of the ERTC it may be expected that subsequent interaction may be artificially oriented around the topic of technology. The presence of a representative of an organisation promoting technology transfer would automatically flag technology as a consideration when solutions to problems or routes to achieve plans were being discussed.

Walker (1985) identifies a number of grounds that indicate the appropriateness of qualitative techniques:

1) Where there is insufficient information or inadequate theory on which to ground and order a logical interview schedule.
2) Where a survey has already been conducted but has produced confusing results.
3) Where the subject is inherently complex and understanding of this complexity is part of the research brief.
4) Where the subject is sensitive so that an interview schedule would elicit only superficial responses.
The nature of the proposed research qualified on the majority of these grounds. Certainly the existing quantitative research conducted by Hausner and the RTCs seemed to be leading to both misleading and confusing conclusions. The search of relevant literature had established an evolving body of theory, but often with conflicting elements and with the most recent theory moving to a view of technology transfer as a complex interactive process. Discussion of problems and plans has already been flagged as an area of potential sensitivity, and problems have been identified with use and interpretation of terminology within the subject area.

4.3.3 THEORETICAL CONSIDERATIONS

On a theoretical level the qualitative techniques indicated by the practical considerations needed to be rooted into the qualitative research tradition, and the research issues relating to qualitative techniques and qualitative data needed to be addressed and resolved.

In order to root the research into the qualitative research tradition it was first necessary to consider the theoretical perspective being adopted. Bogdan and Taylor (1975) provide an overview of the main division in perspective by considering the social science scene being dominated by two major theoretical perspectives. Firstly Positivism, with its origins in the work of Comte and Durkheim and secondly, what they describe as the phenomenological perspective with origins in the work of Weber. The positivists seek 'social facts' and see social phenomena as 'things' and have little regard for subjective states of individuals. Phenomenologists are concerned about understanding human behaviour from an individuals own frame of reference. The appropriateness of methodology adopted for research depends on the theoretical perspective adopted.

"Since the positivists and the phenomenologists approach different problems and seek different answers, their research will typically demand different methodologies. The Positivist searches for 'facts' and 'causes' through methods such as survey questionnaires, inventories and demographic analysis which produce quantitative data and which allow him or her to statistically prove relationships between operationally defined variables. The phenomenologist, on the other hand, seeks understanding through such qualitative methods as

participant observation, open ended interviews and personal documents. These methods yield descriptive data which enable the phenomenologist to see the world as subjects see it." (Bogdan, Taylor, 1975)

The proposed research, quite clearly, was of the type of research seeking to gain an understanding of a phenomena, seeking to determine 'what exists rather that to determine 'how many such things there are' (Hedges, 1981, Bogdan and Taylor, 1975). As such the research falls into the phenomenological or humanistic theoretical perspective and confirms the use of qualitative research methods appropriate to that perspective. The methodological issues that have to be addressed and resolved are the issues relating to the perspective and specifically to qualitative research.

It is not possible, nor is it appropriate, within the space of this thesis to enter into the debate between the positivists and the anti-positivists, however it is important to briefly mention a couple of the more important issues. The problem of 'false consciousness' has been raised by a number of critics (Rex, 1974), and that the 'objective' view of a phenomena might not be that of any of the subjects involved - each of the subjects only being capable of being able to know the small sector of experience in which the subject participates. To a certain extent this issue can be defused by considering that certain research, including this research, was not setting out to determine an 'objective' view of a phenomena, but simply seeks to gain some understanding of the phenomena through the perceptions of the individuals involved.

Methodologically the positivists criticise qualitative methods for being subjective and unstructured (leading to a tendency for research to be unrepeatable and therefore untestable). The role of the researcher in the interpretation of data they see as leading to a largely subjective interpretation, unrepresentative of anything other than the particular instance under research and the researchers subjective interpretation of that instance. Again this argument can be defused by considering that certain research, including this research, is not carried out with a view that the findings should be considered as absolutely representative within a wider context than that of the particular research project. This, however, does not stop the findings being found subsequently as representative, and in the case of policy research, does not stop the findings being assessed for the extent of their predictive capabilities.

By contrast, advocates of qualitative research see the interpretive role of the researcher as vital.

"In qualitative research the investigator serves as a kind of 'instrument' in the collection and analysis of data. This metaphor is a useful one because it emphasises that the investigator cannot fulfil qualitative research objectives

without using a broad range of his or her own experience, imagination, and intellect in ways that are various and unpredictable.
It is especially the complexity and depth of the qualitative research enterprise that encourages this aspect of qualitative methods. Qualitative data are normally relatively messy, unorganised data. It demands techniques of observation that allow the investigator to sort and 'winnow' the data, searching out patterns of association and assumption." (McCracken, 1988)

4.4 THE RESEARCH DESIGN - PHASE 2

4.4.1 IDENTITY OF THE RESEARCHER

The first problem to be resolved was that of the identity of the researcher. It is well known that the perception of the researcher, by the subject, is a source of subsequent bias in the way that the subject responds. One of the earlier practical considerations was that any approach as the local ERTC representative would be likely to bias any responses towards a link with technology. Consider the situation of an accountant turning up at a small business and stating 'I'm an accountant'. Clearly subsequent discussion is likely to be biased in terms of financial matters or accounting. It was therefore proposed that the researcher should approach the SMEs in his other more neutral role as a representative of the Applied Research Centre seeking to talk about the whole range of regional assistance measures for small companies (again part of the researcher's other role). This would mean that the interview could be established with a complete range of types of assistance for SMEs in mind without establishing any biasing links with technology or technical solutions or means prior or during the interview. There was clearly an ethical issue involved here but after considerable discussion by the Panel it was considered acceptable, in that the approach was quite legitimately part of the role of the researcher, as part of his normal activities at the Applied Research Centre. The data was being gathered incidently from work which would have, in any case, taken place, and from which the SMEs were obtaining positive benefits.

4.4.2 SELECTION OF RESEARCH TECHNIQUE

Of the qualitative techniques discussed by the Panel, the interview appeared to the most suitable to seek an understanding of the problems and plans of individual SMEs. It was, however, considered important that the approach to the interview should be structured in such a way as to make it repeatable by other researchers and with groups other than the research sample. The solution was seen as being a focussed, semi-structured interview schedule which would guide respondents to the topic (SME problems and plans) and would elicit the respondents own perception of their own particular problems and plans. This

elicited agenda would then form the subject of further questions to elicit the SMEs perception of solutions to problems, and means to achieve plans. In this way neither the agenda of problems and plans, nor solutions or means, would be defined in any way by the researcher. An interview schedule was drafted (Appendix B) which consisted of a succession of open ended questions, explained by Kerlinger (1973) as "those that supply a frame of reference for respondents answers, but put a minimum of restraint on the answers and their expression".

Cohen and Manion (1985) summarise the advantages of open ended questions

"Open ended questions have a number of advantages: they are flexible; they allow the interviewer to probe so that he may go into more depth if he chooses, or clear up any misunderstandings; they enable the interviewer to test the limits of the respondents knowledge; they encourage co-operation and help establish rapport; and they allow the interviewer to make a truer assessment of what the respondent really believes"

4.4.3 DESIGN OF INTERVIEW SCHEDULE AND DATA CAPTURE FORM

The interviews were arranged over the phone for the purpose of looking at national and international regional assistance for SMEs which includes a full range of measures relating to finance, labour, employment, training, technology, re-location, R&D, advice, standards etc. Discussion of problems and plans is an appropriate method of locating appropriate initiatives or assistance (part of the subsequent procedure was that the researcher returned with a pack of relevant details for the SME)

The phase 2 interview schedule was designed to try to enable the following :

1) To elicit what the respondent identified as the key problems facing the SME at that particular time.
2) To explore each identified problem by considering the causes of the problem and its effects - to encourage the respondent to mentally map out the main elements of the problem.
3) To identify the respondent's perception of solutions - what was required to solve the problem.
4) To seek the respondent's rough assessment of the relative importance of the identified solutions by simple ranking in order.

Then once each of the problems had been explored (and some rapport established) the topic of the owner's or director's plans for the business was introduced. The rest of the schedule then sought to enable the following :

1) To elicit what the respondent identified as the main elements of his plan for the business.
2) To identify the respondent's perception of the main objectives of the plan.
3) To seek the respondent's rough assessment of the importance of these objectives by simple ranking in order.
4) To elicit the respondent's perception of requirements to achieve or meet the objectives.
5) Finally to seek the respondent's rough assessment of the importance of these requirements by simple ranking in order.

The design of the schedule permitted each problem to be considered in isolation - causes, effects and requirements being specifically identified for each individual problem. The 'plans' section of the schedule was designed to treat 'the plan' as an aggregated whole and not as a series of separate objectives. The purpose of this strategy was to try to capture a more general perception of what the interviewee saw as being necessary for the achievement of plans of the SME rather than a series of specific requirements related to specific objectives within the plan.

The wording of the schedule was designed to be the minimum possible to introduce the interviewee to the topic in order not to in any way guide the subsequent response. A copy of the interview schedule is appended in Appendix B

Consideration of how the data should be captured posed a number of special issues. Under the circumstances of the proposed interview, and given the potentially sensitive nature of the proposed discussions, it was considered inappropriate to try to tape record the interviews (and certainly unethical to do so covertly). Open ended questions in the interview situation typically yield relatively large volumes of data and as the researcher is not able to take shorthand some data reduction at point of data capture had to be considered. The solution was two specially designed data capture forms (see Appendix B). The forms were designed to permit the capture of the main summary points made by the SME under each of the main sections of the interview schedule. In order to minimise any interviewer bias in the data reduction at capture, the interview would consist of a response (often quite lengthy) under each of the main sections of the schedule, and then the interviewer would ask the interviewee to summarise the interviewee's view of the main points for capture.

There are clearly many sources of 'noise' which can enter into qualitative interviews of this type. For example it was noted on a couple of occasions when the form was being completed that an interviewee would spend considerable time talking about a subject of great personal concern, and then completely overlook the point when summarising the main points for capture.

some summary points seemed to be introduced without them forming any significant part of the previous response. In both these instances the interviewee summary points were recorded rather than any revision as a result of an intervention by the interviewer.

4.4.4 SELECTION OF RESEARCH SAMPLE

The choice of SMEs in the engineering industry was determined by two factors. Firstly the engineering industry has been, and still is specifically targeted by government innovation policy. The engineering industry is a particularly important sector of UK manufacturing industry

"The Engineering Industry produces two-fifths of United Kingdom manufacturing output, so our prosperity rests on its prosperity" (Institute of Economic Affairs, 1992)

Growth and employment within the engineering industry had become a source of concern, and seen to be symptomatic of the decline in the UK manufacturing base.

"Real growth in engineering output in the UK has been slower than our major competitors .... the share of engineering output as a proportion of GDP has been falling over several decades" (Institute of Economic Affairs, 1992)

Employment in the Engineering Sector 1979 and 1989
(thousands of employees)

	1979	1989	%CHANGE
UK	3332	2319	-30.4
ITALY	1962	1574	-19.8
FRANCE	2198	1773	-19.4
USA	8986	8300	- 7.6
WEST GERMANY	4044	4182	+ 3.4
JAPAN	5111	6500	+27.2

Source OECD National Accounts 1989

The second factor behind the selection of SMEs within the engineering industry related to the logistics of carrying out the research. The researcher was based in Luton, site of the UK Vauxhall car manufacturing plant and home to a relatively large number of SME engineering companies, often spun off, and feeding from, the local car and truck manufacturing industry.

4.4.5 SIZE OF RESEARCH SAMPLE

The qualitative research proposed could not be carried out with large numbers of companies because of time and resource constraints. It was also considered as being inappropriate given that the research was intended to demonstrate the nature of the problem rather than to test any particular solution. It was therefore decided that an initial sample of ten companies should be used. This also is very much in line with the qualitative research tradition.

"Typically qualitative methods yield large volumes of exceedingly rich data obtained from a limited number of individuals and whereas the quantitative approach necessitates standardised data collection, qualitative researchers exploit the context of data gathering to enhance the value of the data." (Walker,1985)

McCracken develops this point but offers the warning about claims of representativeness.

"The first principle is that 'less is more'. It is more important to work longer, and with greater care, with a few people, than more superficially with many of them. For many research projects, eight respondents will be perfectly sufficient. The quantitatively trained social scientist reels at the thought of so small a 'sample' but it is important to remember that this group is not chosen to represent some part of the larger world. It offers instead an opportunity to glimpse the complicated character, organisation and logic of culture. How widely what is discovered exists in the rest of the world cannot be decided by qualitative methods, but only by quantitative ones" (McCracken,1988)

The companies selected were relatively small SMEs (20 employees or less) and it was hoped that this would minimise the need to take account of the effects of the internal organisational structure of the SME (Burns and Stalker, 1961). It was assumed that the role of managing director or owner in these small SMEs could be considered as the 'voice' of the SME. In larger companies where internal specialisation (e.g. a finance director to talk about finance) would have been expected to take place, there would seem to be more need to talk to a number of roles within the organisation, as well as considering internal organisational structure.

4.5 BACKGROUND TO ANALYSIS

Analysis of qualitative data has often been considered to have the status of a black art, with meaning being drawn from the collected data by means of the special (unstated) skills and sensitivities of the researcher. Dey (1993) concludes that

"The low status and marginality of qualitative research generally have fostered defensive posturing which emphasises (and perhaps exaggerates) the subtleties and complexities in qualitative analysis" (Dey, 1993)

Dey considers qualitative literature to be littered with complaints about the lack of clear accounts of analytic principles and procedures and their application in social research. He concludes that part of the problem may be that the analytic procedures may seem deceptively simple.

Dey proposes that qualitative data analysis can be seen as a logical succession of steps leading from first encounters with the data through to the production of an account. The steps he identifies are:

1. Find a focus for the data
2. Organise (manage) the data
3. Read, study and annotate the data
4. Categorise the data
5. Link and connect categories of data
6. Seek corroborating evidence
7. Produce an account

The analysis of the research data followed this particular pattern. The focus for the data had been determined at the start of the research project to the extent that the data was being collected to gain some understanding of a specific proposition. The data record sheets had been designed to provide the structure and organisation of the data collected. The record sheets were studied and annotated and a categorisation of the data formulated. The data was then grouped into the identified categories. Details of the categorisation of data and the analysis follow in the next chapter.

CHAPTER 5

5. ANALYSIS OF DATA

The analysis of the data collected during the interviews began with the categorisation of data and then the classification of the data into the identified categories.

5.1 CATEGORISATION OF DATA

Categorisation was based on the actual expression, by the SMEs, of their problems and plans rather than on any attempt to 'interpret' or to trace any 'underlying' factors.

Following detailed examination of the data record sheets and a number of revisions of categorisation scheme, the following scheme was adopted.

5.1.1 CATEGORISATION OF PROBLEMS PERCEIVED BY SMEs

Problems were categorized into the following types:

1) VOLUME OF WORK/NEED MORE BUSINESS
This category included problems identified as 'not having enough work', 'need more business', 'shortage of work', 'not enough work due to recession'.

2) ACCESS TO FINANCE/OBTAIN FINANCE
This category included problems identified as 'difficulty with finance', 'need to raise money', 'need access funding', 'funding of company' 'problems with borrowing'

3) NEED TO OBTAIN SKILLED LABOUR
This category included problems identified as 'cannot get properly trained labour', 'shortage of skilled labour'

4) COMPLYING WITH LEGISLATION/BS 5750 (STANDARDS)
This category presented some problems, in that at the start of the analysis the two major problems that the SMEs identified were complying with environmental standards and complying with BS5750, and it was therefore decided to categorise them together as 'complying with standards'. However during the analysis it became apparent that the link between BS5750 and technology was substantially different to the link between environmental standards and technology. This point is taken up later in the report on the analysis. The category however included problems identified as 'requirement to obtain 5750', 'meeting 5750 requirements', 'compliance with new environmental legislation', 'meeting environmental standards'.

5) NEED TO CUT COSTS
In terms of problems this category was specific to one SME and referred to problems identified as 'maintain quality but cut costs', 'need to cut costs because...'.

6) BROADEN CUSTOMER BASE
This category included 'dependence on too few clients', 'decline in aerospace' (where the major companies for the SME were aerospace companies.

7) CASH FLOW
This category included 'cash flow problems as a result of late payments', 'customers not paying on time', 'large companies taking credit'

8) NEW/OWN PRODUCTS
This category included 'would like to manufacture new product',' like to develop own product', 'development of new product'

9) RENT AND RATES
This category was specific to one SME who identified a problem with rent and rate rises on his premises 'business rates gone up by 50%'.

10) EQUIPMENT/TECHNOLOGY
This category would have been the category for any identified problems relating to identification, acquisition or use of technology. In fact only one SME identified a problem concerned with the acquisition of some additional machinery for a specific job.

5.1.2 CATEGORISATION OF SOLUTIONS TO PROBLEMS

1) FINANCE, CAPITAL, INTEREST RATES, BORROWING
All identified solutions that were generally financial in nature were included under this heading and included 'finance for business expansion', 'banks need to take longer term view', 'reduction in interest rates'

2) END TO RECESSION, ECONOMIC UPTURN
This category included all solutions identified with the end of the recession, revival of the economy and government measures (unspecified) to end the recession. These included 'end of recession', 'upturn in business', 'general pickup in orders and the economy', 'pick up in business'.

3) INCREASED MARKETING/MORE SALES EFFORT
All mention of sales or marketing solutions were included under this heading. This included 'exhibitions and advertising', 'employ salesman'

4) MORE HIGHLY SKILLED OR QUALIFIED LABOUR
All solutions including education or training of labour and any reforms of the educational system were included. 'change of attitudes of schools', 'training on shop floor', 'training for use (of new equipment)'

5) ACQUISITION OF NEW PLANT, MACHINERY, TECHNOLOGY
This category would include all solutions relating to the acquisition or use of equipment, plant, machinery and new technology, or the transfer of technical know-how or information. This category included 'fit extraction unit',' new equipment for monitoring'

6) LESS BUREAUCRACY AND RED TAPE
Solutions involving less form filling, fewer regulations and fewer requirements to comply with standards were placed in this category. Examples include 'reduced pressure for SMEs to comply', 'simplified systems for SMEs', 'flexibility in implementation'.

7) STATUS OF ENGINEERING
This solution was identified by only one company as one of the solutions to obtaining skilled labour 'change attitudes about engineering in schools'.

8) RETURN OF BUSINESS CONFIDENCE, WILLINGNESS TO INVEST
The end to the recession and a return of business confidence were two solutions that were often linked. If confidence was specifically mentioned then this category was used. Examples include 'return of confidence and an end to the recession', 'need confidence to invest'.

9) PAYMENTS ON TIME - INTEREST ON LATE PAYMENTS
This category of solutions related specifically to the cash flow problem and included 'interest if late payment', 'payment on time'.

10) ADVICE, HELP AND INFORMATION
All non technology related provision of assistance and information was placed under this heading. Examples include 'independent advice (on financial matters)', 'information on venture capital'

11) PICK UP IN LARGE COMPANIES
Some SMEs were dependent on large companies for the bulk of their business and identified 'pick up in truck and aerospace companies', 'pick up in local large companies'. These were included in this category.

12) GRANTS, ASSISTANCE, STARTER UNITS, TAX BENEFITS
This category included all the public sector financial schemes 'government start up schemes', 'loans by government to help small businesses', 'financial assistance', 'government grant'.

13) MISCELLANEOUS
All solutions not falling into the categories above were placed in this category and some individual explanation about these items is included in the section of this chapter detailing the results.

5.1.3 CATEGORISATION OF OBJECTIVES OF PLANS

1) MAINTAIN EXISTING SHARE OF BUSINESS/ SURVIVE
This category includes all objectives which included 'survive the recession', 'keep business going despite recession', 'maintain business going'

2) SOLVE CASH FLOW
References to 'get bank off back', and 'solve cash flow' were included under this heading.

3) EXPANSION
'Expansion when economy picks up', 'expand to take up capacity', 'grow when economy picks up' are typical of the references included in this category.

4) OBTAIN BS5750
Two companies specifically stated plans to obtain BS5750.

5) EQUIPMENT/TECHNOLOGY
All references to acquiring new technology, equipment or plant were included under this heading. Examples include 'maximise use of CAD/CAM', 'examine possibility for CNC', 'improve machinery', 'develop CNC capacity'

6) DIVERSIFY CUSTOMER BASE
One SME identified diversification of his customer base.

7) NEW MANAGEMENT/STAFF
One SME identified the acquisition of new managerial staff.

8) INTRODUCE NEW/OWN PRODUCTS
All references to 'move to own products', 'like to introduce own product', 'add new product to range', 'new products', 'start new project' were included under this heading.

9) EXPAND SALES/MARKETING
One SME identified increased sales effort.

10) JOINT VENTURE LINKS
One SME identified the assessment of a joint venture.

5.1.4 CATEGORISATION OF REQUIREMENTS TO MEET OBJECTIVES

There was a great degree of similarity between the requirements that the SMEs identified to meet the objectives of their plans, and the solutions that they identified to their problems. It was therefore possible to use some of the categories for solutions also for requirements to meet objectives.
The existing categories that were found to be usable were:

1) FINANCE, CAPITAL, INTEREST RATES, BORROWING
2) END TO RECESSION, ECONOMIC UPTURN
4) MORE HIGHLY SKILLED OR QUALIFIED LABOUR
5) ACQUISITION OF NEW PLANT, MACHINERY, TECHNOLOGY
8) RETURN OF BUSINESS CONFIDENCE, WILLINGNESS TO INVEST
11) PICK UP IN LARGE COMPANIES
12) GRANTS, ASSISTANCE, STARTER UNITS, TAX BENEFITS

The new categories that were added to complete the categorisation were:

1) DIVERSIFY/DEVELOP OWN/NEW PRODUCT
This category included all references to developing new or own products as a means of expanding or diversifying the companies products. Typically these included 'move to own products to reduce dependence', 'consider own products', 'develop new lines of business'.

2) MAINTAIN EXISTING LEVEL OF BUSINESS
One SME identified this specifically.

3) OBTAIN APPROVALS/BS5750
Three of the SMEs identified meeting the BS5750 standard as a requirement.

4) JOINT VENTURE
One SME identified a joint venture as a requirement for his plan to develop a new product.

5.1.5 CLASSIFICATION AND SIMPLE WEIGHTING

Following completion of the categorisations, the data capture forms were then re-examined and the data classified into the identified categories. SMEs had been asked to rate, by simple ordering in importance, certain of the items on the forms. A simple weighting scheme of 3 to the item identified as most important, 2 to then next most important, and 1 to the remainder was adopted. This simple weighting scheme has no intrinsic significance other than to give some expression to the ranking that the SMEs had applied to the data.

DETAIL COMPANY	TYPE OF COMPANY	NUMBER OF EMPLOYEES	TYPE OF MARKET	POSITION OF INTERVIEWEE		
A C	SUB-CONTRACT ENGINEERING	2 FT	PRECISION & GENERAL MACHINING & FITTING	OWNER		
A L	OWN & SUB-CON ENGINEERING	4 FT	PATTERNS CASTING MACHINING & FITTING	OWNER		
B E	SUB-CONTRACT ENGINEERING	7 FT	PRECISION ENGINEERING	MANAGING DIRECTOR		
B L	SUB-CONTRACT ENGINEERING	8 FT	STEELWORK - FIRE ESCAPES - CAT WALKS	MANAGING DIRECTOR		
B O	SUB-CONTRACT ENGINEERING	12 FT	SHEETMETAL WORK PRESSWORK TOOLMK	MANAGING DIRECTOR		
B R	OWN & SUB-CON ENGINEERING	2 FT 1 PT	BRACKETS (OWN) JIGS TOOLS & PREC	MANAGING DIRECTOR		
C U	OWN & SUB-CON ENGINEERING	16 FT 2 PT	HANDLING MACHINERY	MANAGING DIRECTOR		
D E	OWN & SUB-CON ENGINEERING	3 FT	CASTING & MACHINING	MANAGING DIRECTOR		
GI	SUB-CONTRACT ENGINEERING	18 FT	MOULD AND TOOLMAKERS	MANAGING DIRECTOR		
M D	SUB-CONTRACT ENGIEERING	1 FT	GENERAL ENGINEERING	OWNER		
W A	SUB-CONTRACT ENGINEERING	8 FT	MACHINERY PUMP PARTS	DIRECTOR		
W E	SUB-CONTRACT ENGINEERING	20 FT	AEROSPACE ENGINEERING	MANAGING DIRECTOR		

Fig 5.2(a) DETAILS OF COMPANIES IN SAMPLE

5.2 PRESENTATION OF FINDINGS

In order to examine the data the findings were presented in summary form on a number of tables and then in graphical form as a series of bar charts. The effect of using the simple weighting system was also presented in table and chart form to give a rough feel for the ordering of data by the SMEs.

5.2.1. SAMPLE FOR PHASE 2

The original sample consisted of ten small engineering companies. They all had 20 or fewer employees. The characteristics of each of the companies are set out in Fig 5.2(a). During the time between phase 2 and phase 3 two of the companies (DE and BE) closed down and two new companies (WA and WE) were selected as replacements and participated in both phase 2 and phase 3. As a result the sample for phase 2 now consists of 12 companies.

5.2.2. ANALYSIS OF PROBLEMS - PHASE 2

The analysis of the problems perceived by the companies as the most important problems facing their businesses is shown in Fig 5.2(b) and Fig 5.2(c) It can be seen that, as may have been anticipated, many of the companies problems stem from the effects of the recession. Concerns about the low levels of business and the need to obtain more work represent the most frequently perceived problems. In addition problems identified as the need to improve cash flow, the need to cut costs, the need to introduce new products and the accessing of additional or new sources of finance, can also be seen as recession related. Perhaps it is also relevant to mention at this point that there was a gap of about nine months between phase 2 and phase 3, but although the end to the recession was much reported in the press, the SMEs in the sample reported that, for them, the recession was still very much in evidence.

Small engineering companies were also under pressure from suppliers to conform to BS5750 quality assurance standards and a number of companies reported that certain customers were threatening to remove them from approved supplier lists unless they became BS5750 approved. The cost and bureaucratic overhead of compliance was the second most frequently identified problem. This problem was linked in the earlier analysis to the problem of complying to certain environmental standards. Two of the companies in the sample were involved in making small castings and were under pressure to conform to new environmental standards for emissions from their furnaces into the atmosphere.

The picture presented by the analysis of problems perceived by the SMEs is, as may have been expected, that of small companies pre-occupied with their

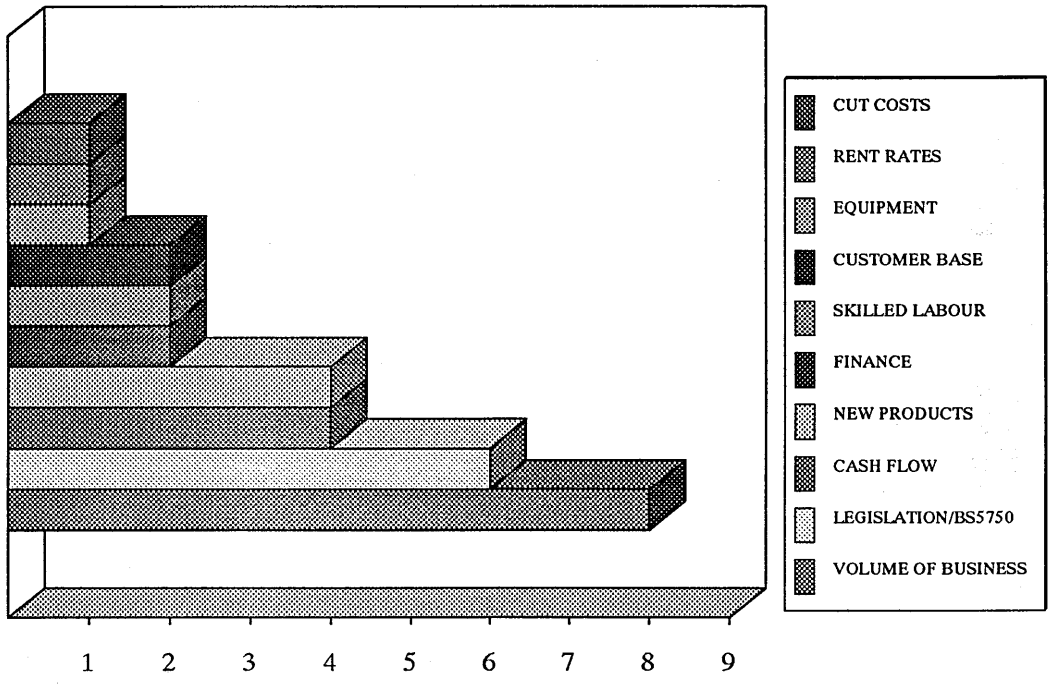
PROBLEM COMPANY	VOLUME OF BUSINESS NEED MORE B	ACCESS TO FINANCE	OBTAIN SKILLED LABOUR	COMPLY LEGISLN & BS 5750	NEED TO CUT COSTS	BROADEN CUSTOMER BASE	CASH FLOW	NEW/OWN PRODUCTS	RENT AND RATES	EQUIPMENT TECHNOLOGY	
AC	X	X					X				
AL				X							
BE	X				X	X					
BL	X		X								
BO	X	X					X				
BR				X						X	
CU	X							X			
DE	X			X				X			
GI	X		X					X			
MD				X			X	X	X		
WA	X			X			X				
WE		X		X		X					

Fig 5.2(b) ANALYSIS OF PROBLEMS BY COMPANY

immediate problems. At that point in time the two major sources of immediate problem, the recession and compliance with standards, were of particular concern.

The acquisition of equipment was identified as a problem by one company because they again had an immediate need (that of unloading materials and presswork required, for a specific job). This had led to their perception of the problem as that of acquiring identified machinery (a small crane and a hydraulic press).

Fig 5.2(c) ANALYSIS OF PROBLEMS BY COMPANY
NUMBER OF COMPANIES IDENTIFYING EACH PROBLEM



5.2.3. ANALYSIS OF SOLUTIONS - PHASE 2

The analysis of the solutions that the SMEs perceived as solving their problems is shown in Fig 5.2(d) and Fig 5.2(e). Fig 5.2(d) shows the companies identifying each category of solution along with the simple weighting score (see research design). The final weighting totals for all SMEs, in each of the categories, is shown in Fig 5.2(e).

Each main category of problem will now be examined with respect to the perceived solutions.

PROBLEM SOLUTION	VOLUME OF BUSINESS NEED MORE B	ACCESS TO FINANCE	OBTAIN SKILLED LABOUR	COMPLY LEGISLN & BS 5750	NEED TO CUT COSTS	BROADEN CUSTOMER BASE	CASH FLOW	NEW/OWN PRODUCTS	RENT AND RATES	EQUIPMENT TECHNOLOGY
Finance, Capital - Interest rates- easier borrowing, reform of	3 (AC)3(CU) 2(DE)2(WA)	3 (WE)		2(MD)3(WA)			1(AC)2(WA)	3(CU)3(DE) 3(GI)2(MD)		
End to recession - economic upturn action by government	3(BO)2 (CU)3 (DE)3(GI)3W									
Increase marketing more sales effort contacts	3(BE)					3(BE)				
More highly skilled or qualified labour - reform of education	1(DE)		2(BL)		2(BE)					
New equipment - acquisition of plant, machinery, technology				2(AL)1(DE)	3(BE)					
Less beuracracy and red tape				1(AL)3(BR) 2(DE)3(MD)						
Status of engineering			2(GI)							
Return of business confidence willingness to invest	3(BL)2(GI)	2(WE)	3(GI)					2(GI)		
Payments on time interest on late pay							3(AC)2(AC) 3(WA)			
Advice Help information		2(AC)						1(GI)1(MD)		
Pick up in large companies	2(BL)2(BO)									
Grants, assistance, starter units, help with rent and rates	2(AC)1(CU)	3(AC)3(BO)		3(AL)3(DE)		3(WE)				3(BR)
Miscellaneous other	2(BE)		3(BL)1(GI)				3(MD2(MD)	2(CU)3(MD)		

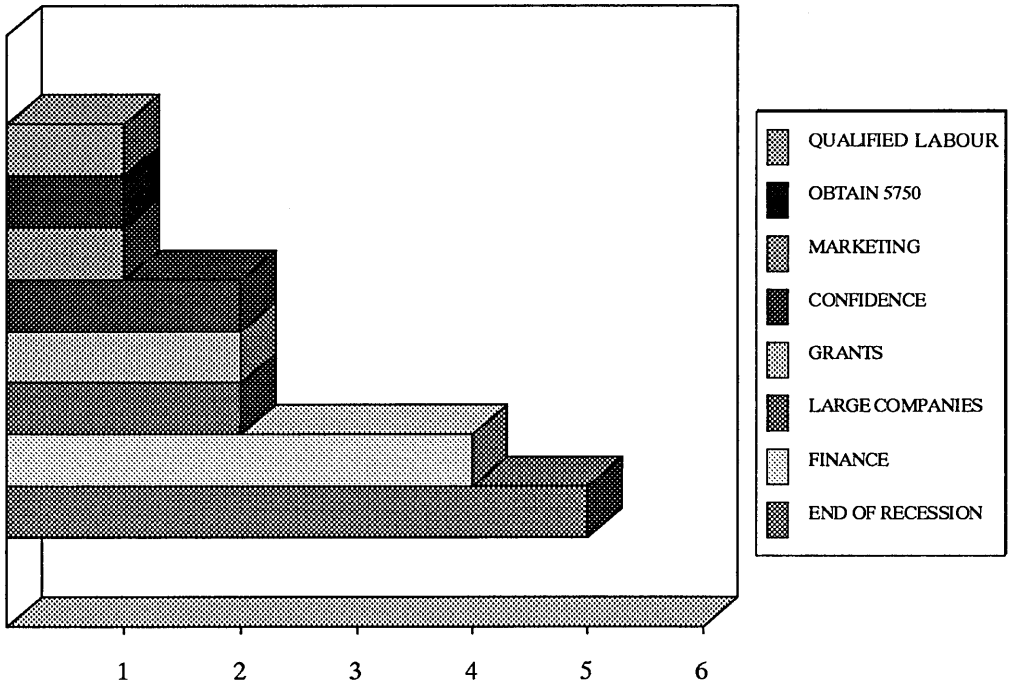
Fig 5.2(d) ANALYSIS OF PROBLEMS BY SOLUTIONS

PROBLEM SOLUTION	VOLUME OF BUSINESS NEED MORE B	ACCESS TO FINANCE	OBTAIN SKILLED LABOUR	COMPLY LEGISLN & BS 5750	NEED TO CUT COSTS	BROADEN CUSTOMER BASE	CASH FLOW	NEW/OWN PRODUCTS	RENT AND RATES	EQUIPMENT TECHNOLOGY
Finance, Capital - Interest rates- easier borrowing, reform of	10	3		5			3	11		
End to recession - economic upturn action by government	14									
Increase marketing more sales effort contacts	3					3				
More highly skilled or qualified labour - reform of education	1		2		2					
New equipment - acquisition of plant, machinery, technology				3	3					
Less beuracracy and red tape				9						
Status of engineering			2							
Return of business confidence willingness to invest	5	2	3					2		
Payments on time interest on late pay							8			
Advice Help information		2						2		
Pick up in large companies	4									
Grants, assistance, starter units, help with rent and rates	3	6		6		3				3
Miscellaneous other	2		4				5	5		

Fig 5.2(e) ANALYSIS OF PROBLEMS BY SOLUTIONS (final weighting totals shown)

5.2.3.1 VOLUME OF BUSINESS PROBLEM

Fig 5.2(f) ANALYSIS OF VOLUME OF BUSINESS PROBLEM BY SOLUTION
NUMBER OF COMPANIES IDENTIFYING EACH SOLUTION

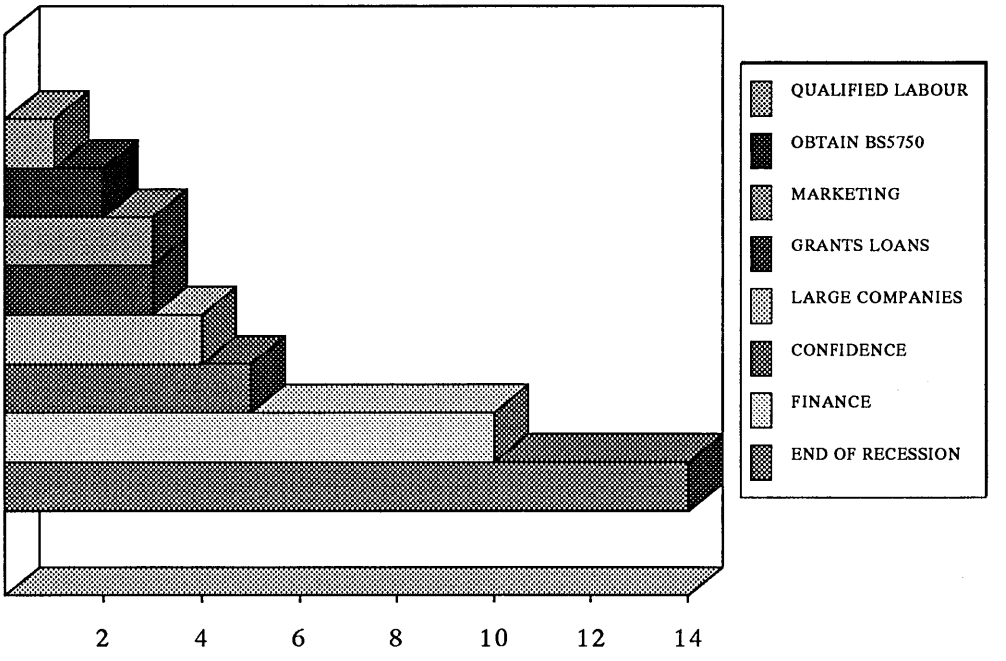


The problem of the volume of business and the need to obtain more work had been identified as a problem by the majority of SMEs in the sample. The identified solutions can be seen as largely externalising the solutions (i.e. identifying solutions which exist outside the SME). For example an end to the recession was widely, and quite reasonably, seen as the solution to the problem of obtaining more work. The solution of easier acquisition of finance, reform of the banks, lowering of interest rates again can be seen as an appropriate, but external solution. The revival of large companies, the provision of grants and loans and a revival in confidence, again all largely external solutions. Perhaps only the solution of increasing sales and marketing effort can be seen as an 'internal' solution to the problem in that the resource devoted to sales and marketing is under the direct control of the SME.

One finding of specific concern to this research is that the acquisition of new plant, equipment or technology was not identified as a perceived solution by any of the companies, particularly to the problem of obtaining more work. During the research there were a number of efforts by the government through their innovation campaigns to draw the attention of SMEs to acquisition of technology as a means to enter new markets of increase market share in existing markets. This finding gave rise to a new and important research question to be addressed in phase 2 of the research:

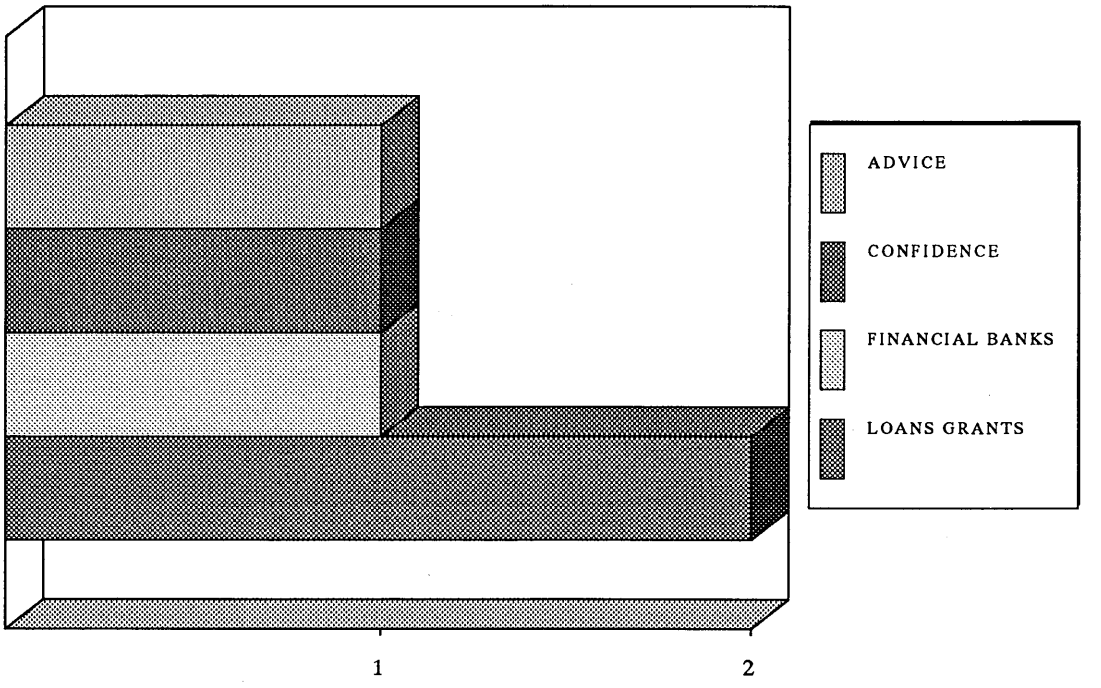
Were the SMEs not identifying the Equipment/Technology option because they had considered it and discarded it for some reason (or alternatively given it a poor rating in comparison with other solutions) or were the SMEs unable to perceive a link between their problem and a technology based solution ?

Fig 5.2(g) ANALYSIS OF VOLUME OF BUSINESS PROBLEM BY SOLUTION (USING SIMPLE WEIGHTINGS)



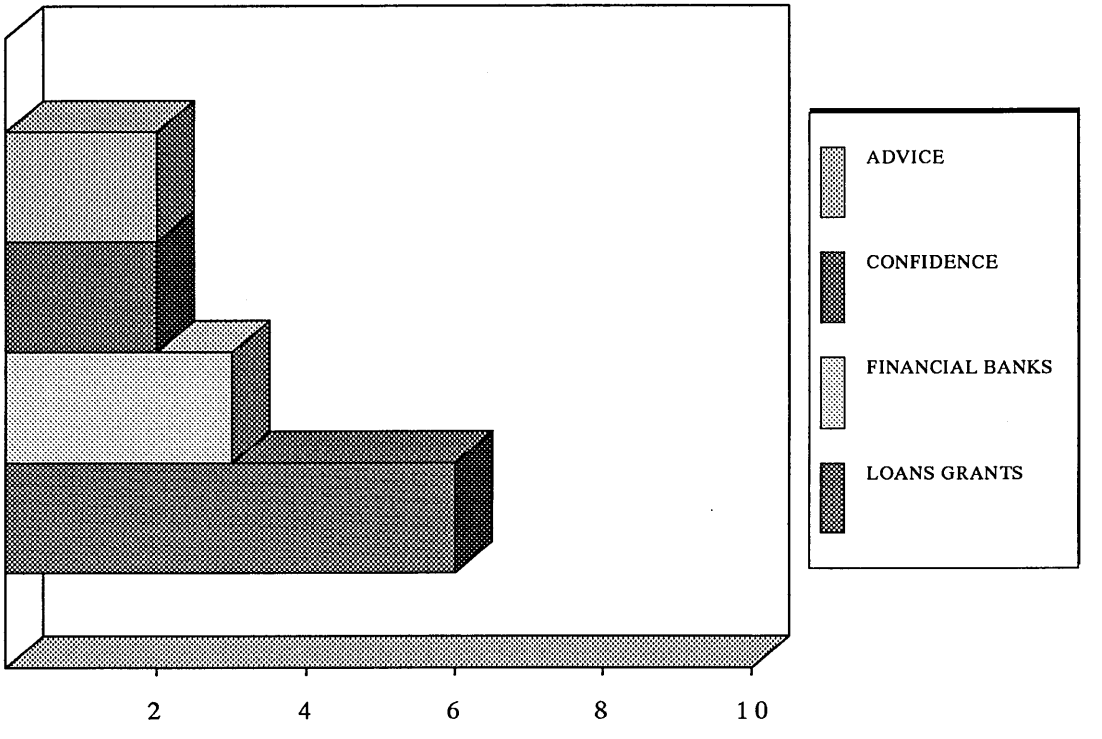
5.2.3.2 FINANCE PROBLEM

Fig 5.2(h) ANALYSIS OF FINANCE PROBLEM BY SOLUTION NUMBER OF COMPANIES IDENTFYING EACH SOLUTION



The problem of access to finance, obtaining overdraft facilities and related activities of Banks was a problem identified by three of the SMEs. Identified solutions tended to be externalised again with, for example, a solution to a shortage of finance being seen as public sector grants or loans, on special terms. The role of the Banks came in for a deal of criticism with the SMEs keen to try to find, or have established, an alternative source to Bank finance. Banks were perceived as being unsympathetic to small businesses and the cause of many small business closures (' pull the plug at the first sign of trouble'). The Managing Director of one of the SMEs could access a source of private finance providing confidence to invest returned to the engineering industry.

Fig 5.2(i) ANALYSIS OF FINANCE PROBLEM BY SOLUTION (USING SIMPLE WEIGHTINGS)



5.2.3.3 SKILLED LABOUR PROBLEM

The perceived problem of the need to obtain appropriately skilled labour, was for the SMEs involved, largely a problem about the wages they were prepared to pay, and as a result the sort of labour they were able to attract. Two of the SMEs specifically identified the payment of higher wages as being a solution to the problem and as this did not fit into the existing classification scheme this solution has been placed in the miscellaneous category in Figs 5.2(d) & 5.2(e) but is identified separately on the analysis bar chart

Fig 5.2(j) ANALYSIS OF SKILLED LABOUR PROBLEM BY SOLUTION NUMBER OF COMPANIES IDENTFYING EACH SOLUTION

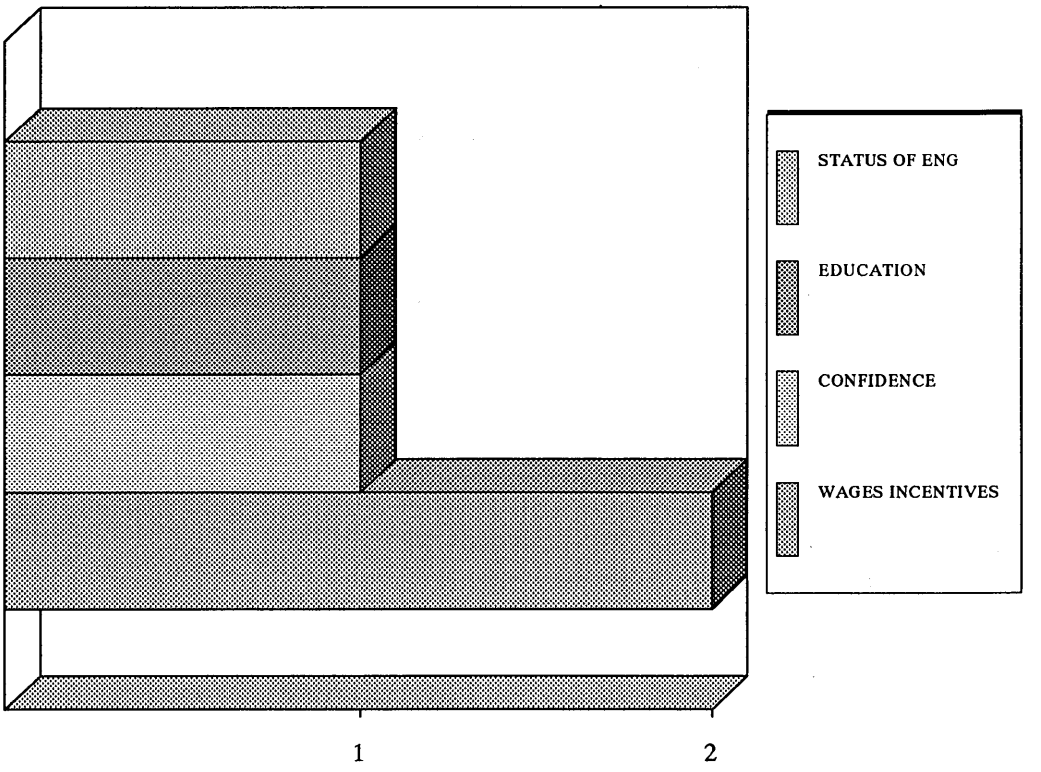
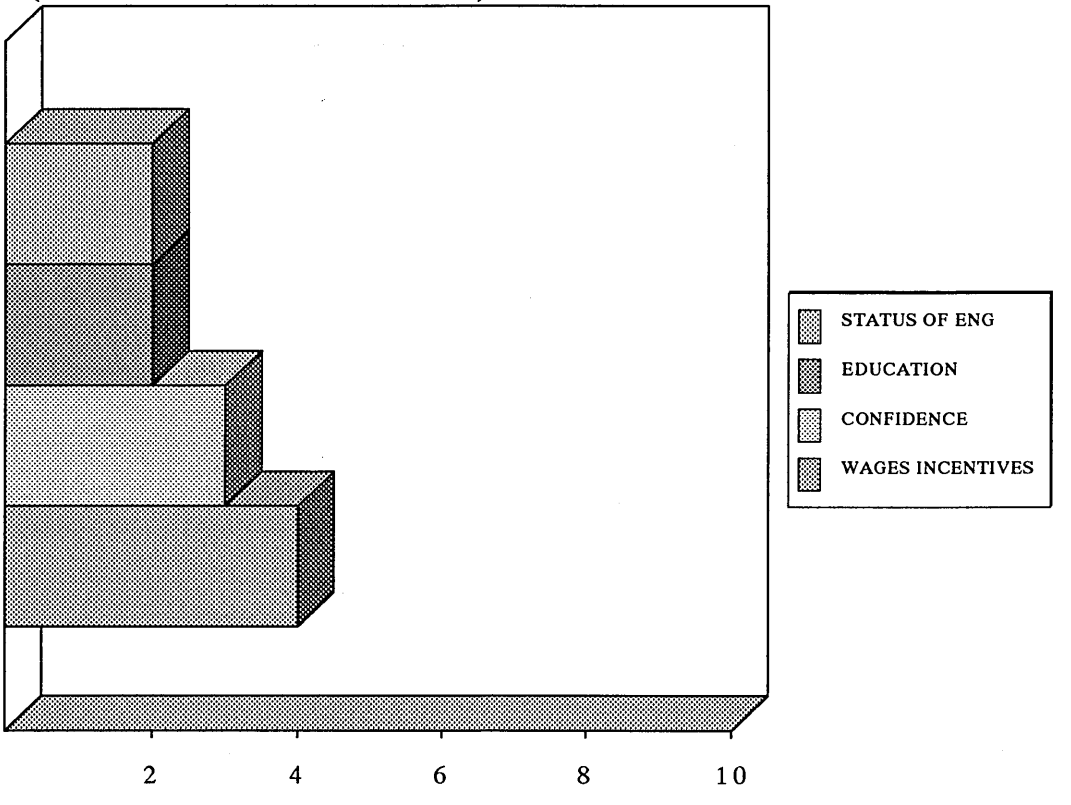


Fig 5.2(k)ANALYSIS OF SKILLED LABOUR PROBLEM BY SOLUTION (USING SIMPLE WEIGHTINGS)



5.2.3.4 COMPLIANCE WITH STANDARDS

The problem of approvals for BS5750 was of particular concern to the SMEs because they feared both loss of business (if they were taken off approved suppliers lists by larger companies) and because implementation would lead to both costs of implement and a continuing administrative overhead to maintain. To most of the SMEs there seemed to be no return on this investment Compliance with these standards was seen as being unnecessary and so a reduction in bureaucracy and red tape, as a solution, was in effect seeing the solution, not as a means of compliance, but in fact postponing or doing away with the need to comply. The standards were the bureaucracy, the red tape, that they wanted to get rid of.

Fig 5.2(l) ANALYSIS OF LEGISLATION/BS5750 PROBLEM BY SOLUTION NUMBER OF COMPANIES IDENTIFYING EACH SOLUTION

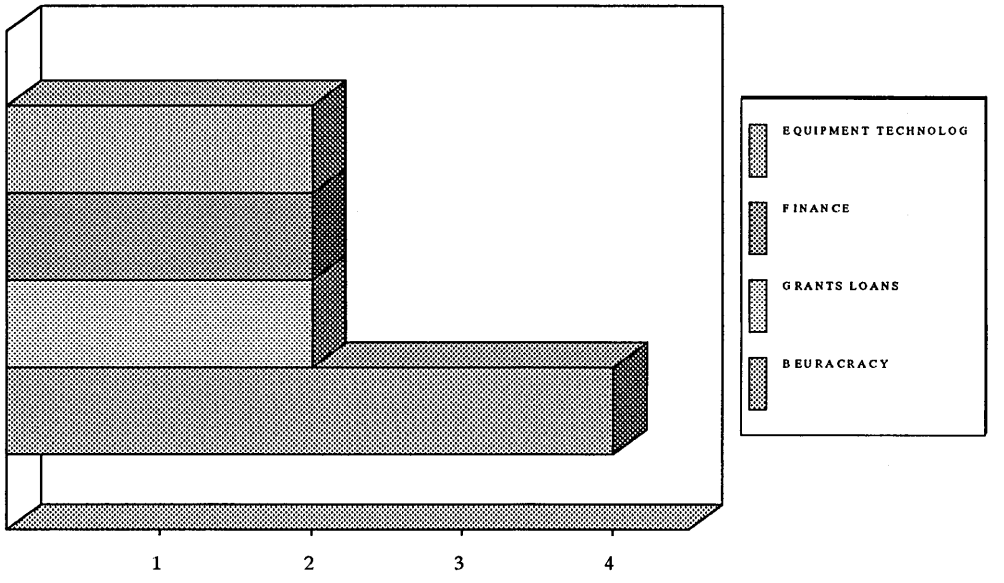
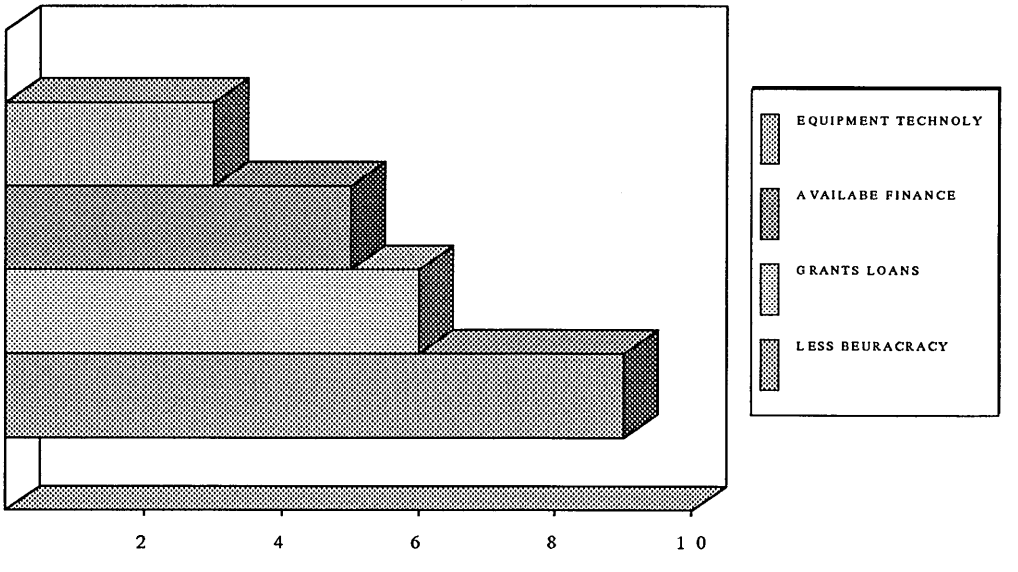


Fig 5.2(m) ANALYSIS OF LEGISLATION/BS5750 PROBLEM BY SOLUTION (USING SIMPLE WEIGHTINGS)



5.2.3.5 COST CUTTING PROBLEM

The need to cut costs was a problem only specifically identified by one company (BE) and in fact this was one of the companies which went out of business between phase 2 and phase 3. It would therefore seem that this problem may have been the 'need to get more work' problem in its more advanced form. If an SME has tried to get more work and failed, then one of the remaining courses of action is to try to survive without getting more work - by cutting costs and trying to survive on the same or a declining amount of work. It is an interesting, but sad reflection that the company in question had identified technology as a solution to the problem of cutting costs and had recently acquired some CNC machinery. The very process of tying up capital in technology at difficult times can mean that any subsequent cash flow crisis cannot be met.

Fig 5.2(n) ANALYSIS OF CUTTING COSTS PROBLEM BY SOLUTION NUMBER OF COMPANIES IDENTIFYING EACH SOLUTION

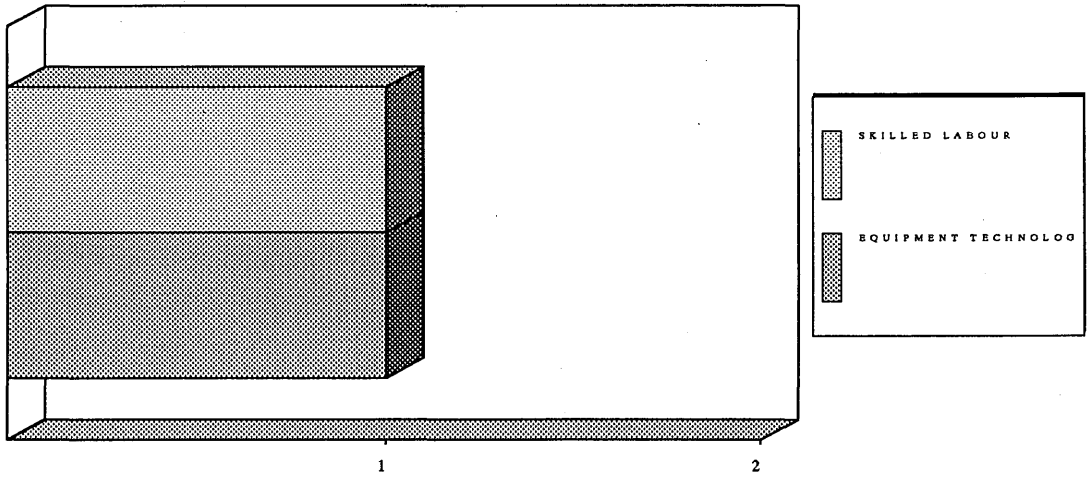


Fig 5.2(o) ANALYSIS OF CUTTING COSTS PROBLEM BY SOLUTION (USING SIMPLE WEIGHTINGS)

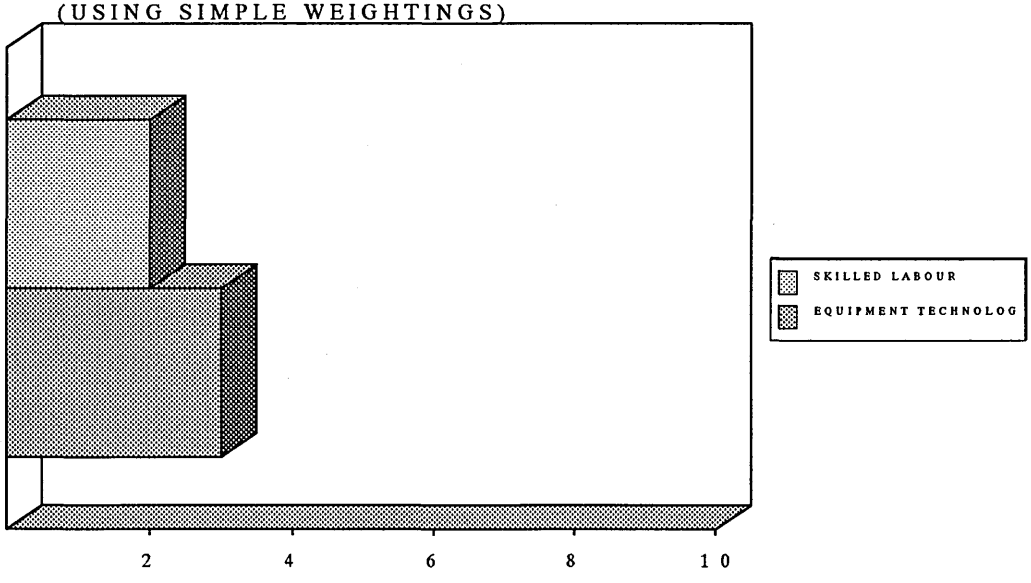
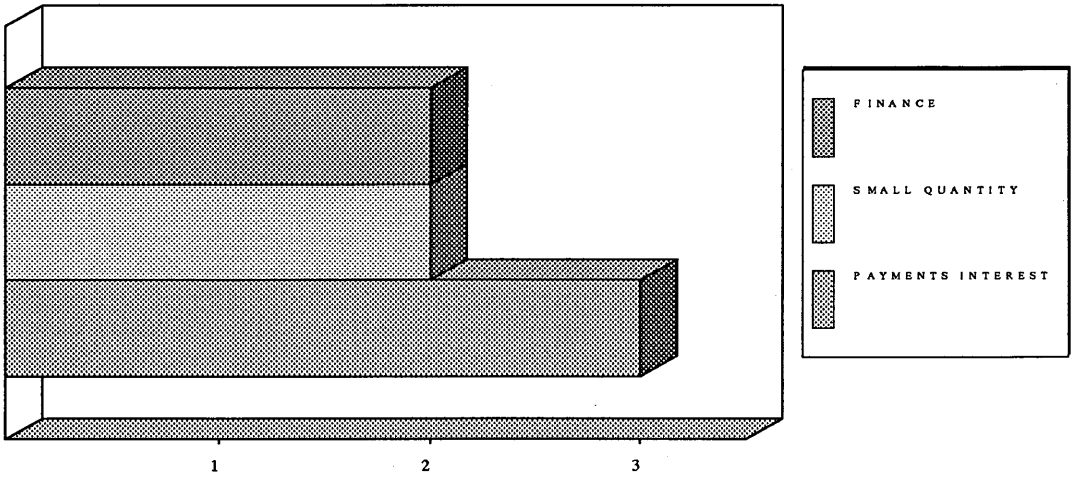


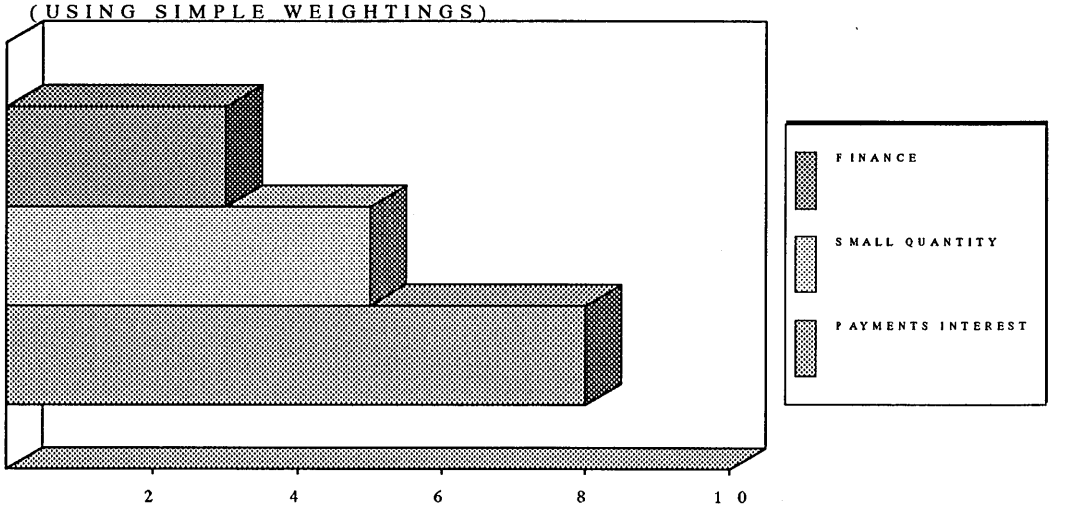
Fig 5.2(p) ANALYSIS OF CASH FLOW PROBLEM BY SOLUTION
NUMBER OF COMPANIES IDENTFYING EACH SOLUTION



5.2.3.6 CASH FLOW PROBLEM

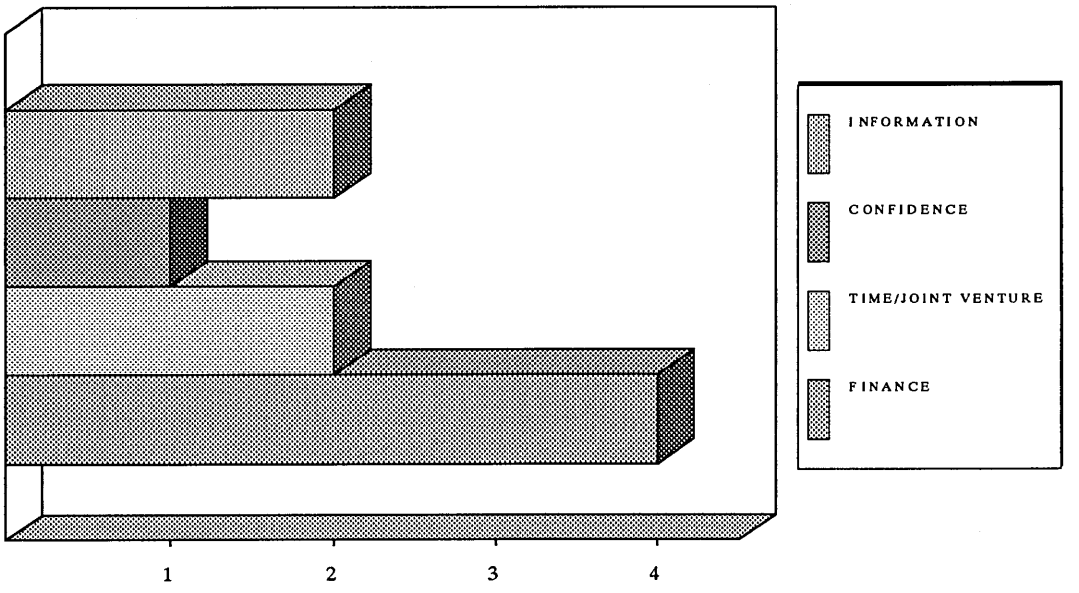
A related problem is that of improving cash flow. The main cause of the perceived problems 'need to cut costs' and 'need to improve cash flow' is the recession, and these problems that the SMEs are identifying would seem to be almost elements of a solution, but expressed as separate problems. Cutting costs and improving cash flow can be seen as methods of dealing with the central problem of the effects of the recession. In terms of a solution to cash flow problems, methods of encouraging large companies to pay up on time, and in particular the ability of SMEs to charge interest for late payments (being actively pursued by the Federation of Small Businesses at the time) were seen as solutions. Easier access to finance (often expressed as 'not through the banking system') was an alternative solution along with a perceived need for SMEs to be able to buy in smaller quantities from steel suppliers and to be able to get sub-contract work done in smaller batches.

Fig 5.2(q) ANALYSIS OF CASH FLOW PROBLEM BY SOLUTION
(USING SIMPLE WEIGHTINGS)



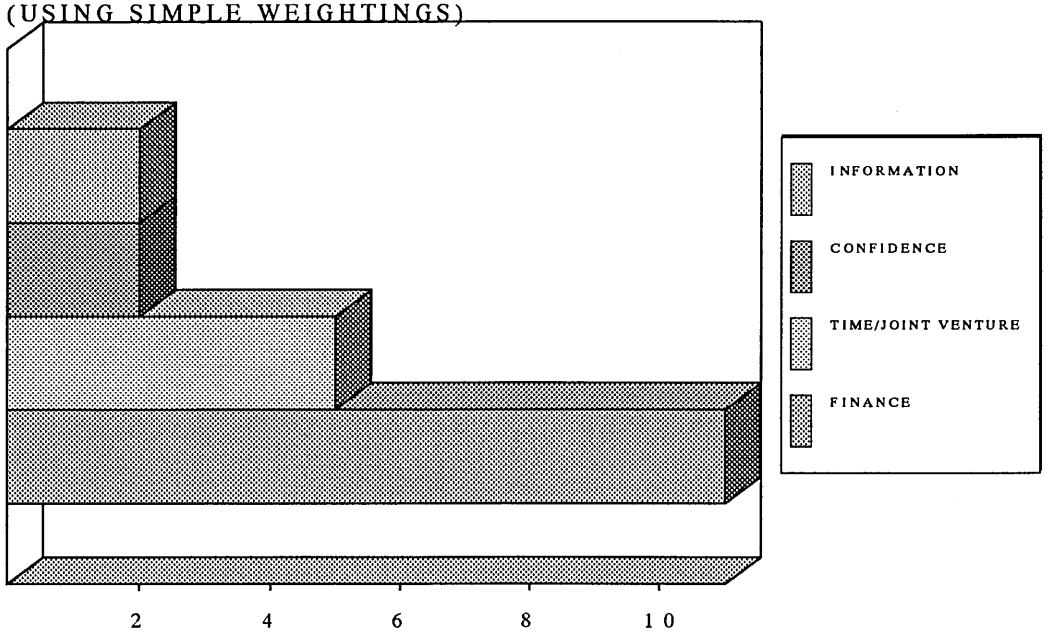
5.2.3.7 NEW PRODUCT PROBLEM

Fig 5.2(r) ANALYSIS OF NEW PRODUCT PROBLEM BY SOLUTION
NUMBER OF COMPANIES IDENTIFYING EACH SOLUTION



Quite a number of the SMEs identified the need for diversification in terms of broadening their customer base or introducing their own, or new, products as a problem. Again this perceived problem can be seen as a solution to a wider problem as well as an implementation problem. Often SMEs find that their products root them in one particular market or indeed root them as a supplier to a single large company. This makes these companies vulnerable to changes in the market or the fortunes of their large customers. Many of the small engineering companies in Luton sprang out of the motor industry in the area

Fig5.2(s) ANALYSIS OF NEW PRODUCT PROBLEM BY SOLUTION
(USING SIMPLE WEIGHTINGS)



(Vauxhall Motors, AWD trucks, Renault trucks), or were suppliers to the defence or aerospace industries (British Aerospace). The decline in the defence and aerospace industries (closure of local British Aerospace factory) and the local automotive industry (closure of AWD) meant that some of the SMEs were under great pressure to find new products or diversify out of their existing markets. Solutions were perceived as being the accessing of appropriate finance to fund these new developments, the return of business confidence and the provision of help, advice and information.

Fig 5.2(t) ANALYSIS OF BROADEN CUSTOMER BASE PROBLEM BY SOLUTION NUMBER OF COMPANIES IDENTIFYING EACH SOLUTION

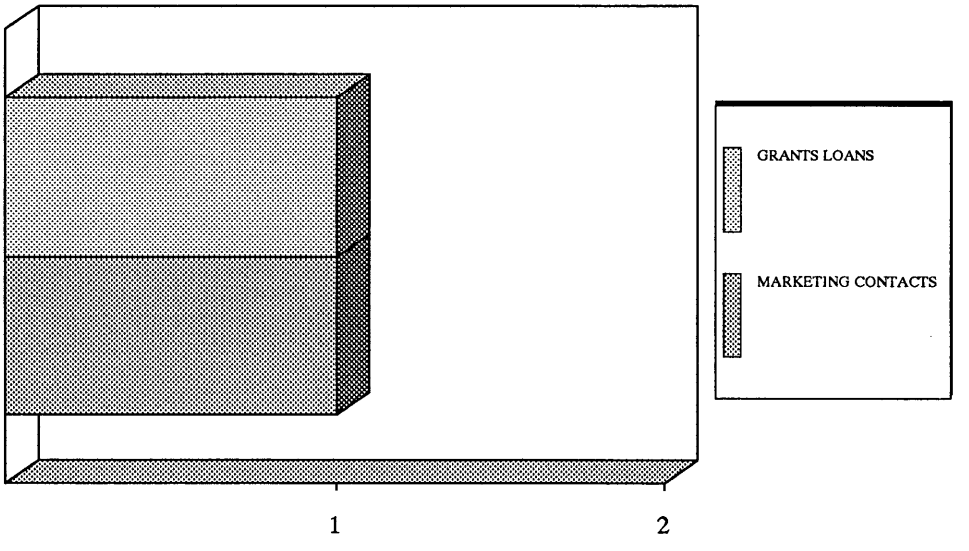
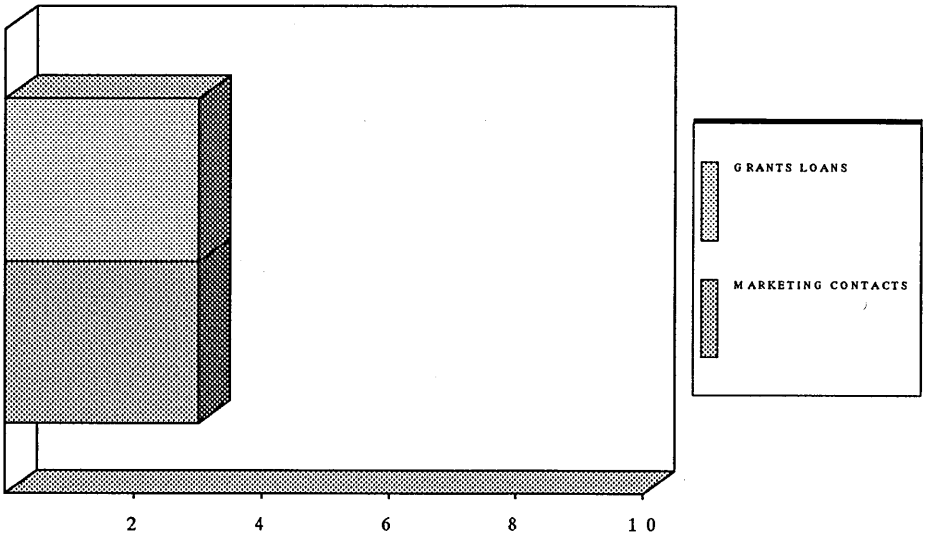


fIG 5.2(u) ANALYSIS OF BROADEN CUSTOMER BASE PROBLEM BY SOLUTION (USING SIMPLE WEIGHTINGS)



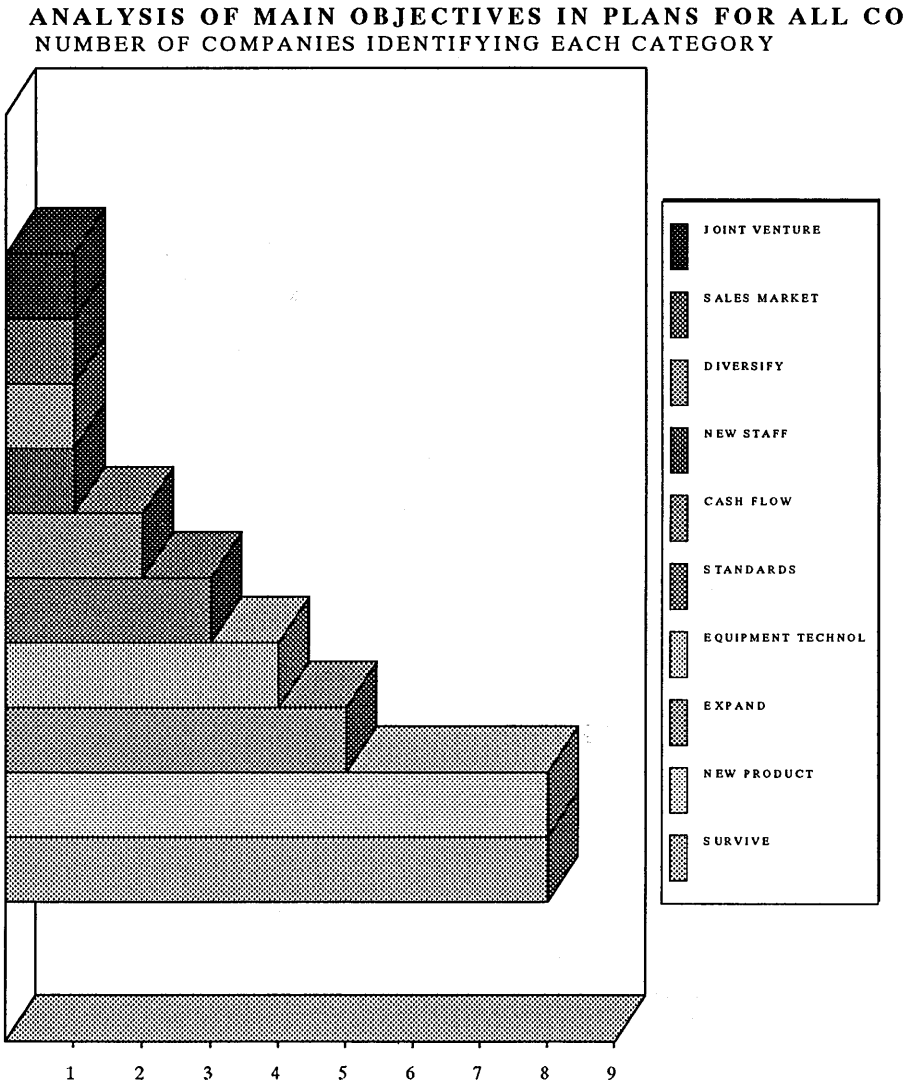
One of the SMEs identified a problem with escalating rent and rates but was resigned to paying them, and therefore could not identify any perceived solutions for his problems.

Another one of the SMEs had a specific need for additional equipment (BR - discussed earlier in this section). The Company identified the single solution of grants or an increase in 'tax incentives'.

5.2.4 ANALYSIS OF PLANS - PHASE 2

5.2.4.1 MAIN OBJECTIVES OF PLANS

The main objectives within the SMEs' plans for the future are summarised in the table shown in Fig 5.2(v) and graphically in Fig 5.2(w). SMEs were also asked to order the main objectives of their plans and the results of this ordering using the simple weighting system proposed in the research design are shown in Fig 5.2(x). The graphical representation of this data is shown in Fig 5.2(y)



Maintaining existing share of business and surviving the recession was frequent featured in the SMEs' immediate plans and if simple weighting is taken into account then the relative importance of just 'surviving' becomes

OBJECTIVE COMPANY	MAINTAIN EXISTING BUS SURVIVE	SOLVE CASH FLOW BANK OFF BACK	EXPANSION WHEN ECON PICKS UP	OBTAIN BS 5750	EQUIPMENT TECHNOLOGY	DIVERSIFY CUSTOMER BASE	NEW MANAGMENT STAFF	INTRODUCE NEW PRODUCTS	EXPAND SALES MARKETING	JOINT VENTURES LINKS	
AC	X	X									
AL	X		X					X			
BE	X				X	X		X			
BL							X		X		
BO			X	X	X						
BR	X				X						
CU	X							X			
DE	X		X					X			
GI			X		X			X			
MD	X			X				X			
WA	X	X	X					X			
WE				X				X		X	

Fig 5.2(v) ANALYSIS OF OBJECTIVES IN PLANS BY COMPANY

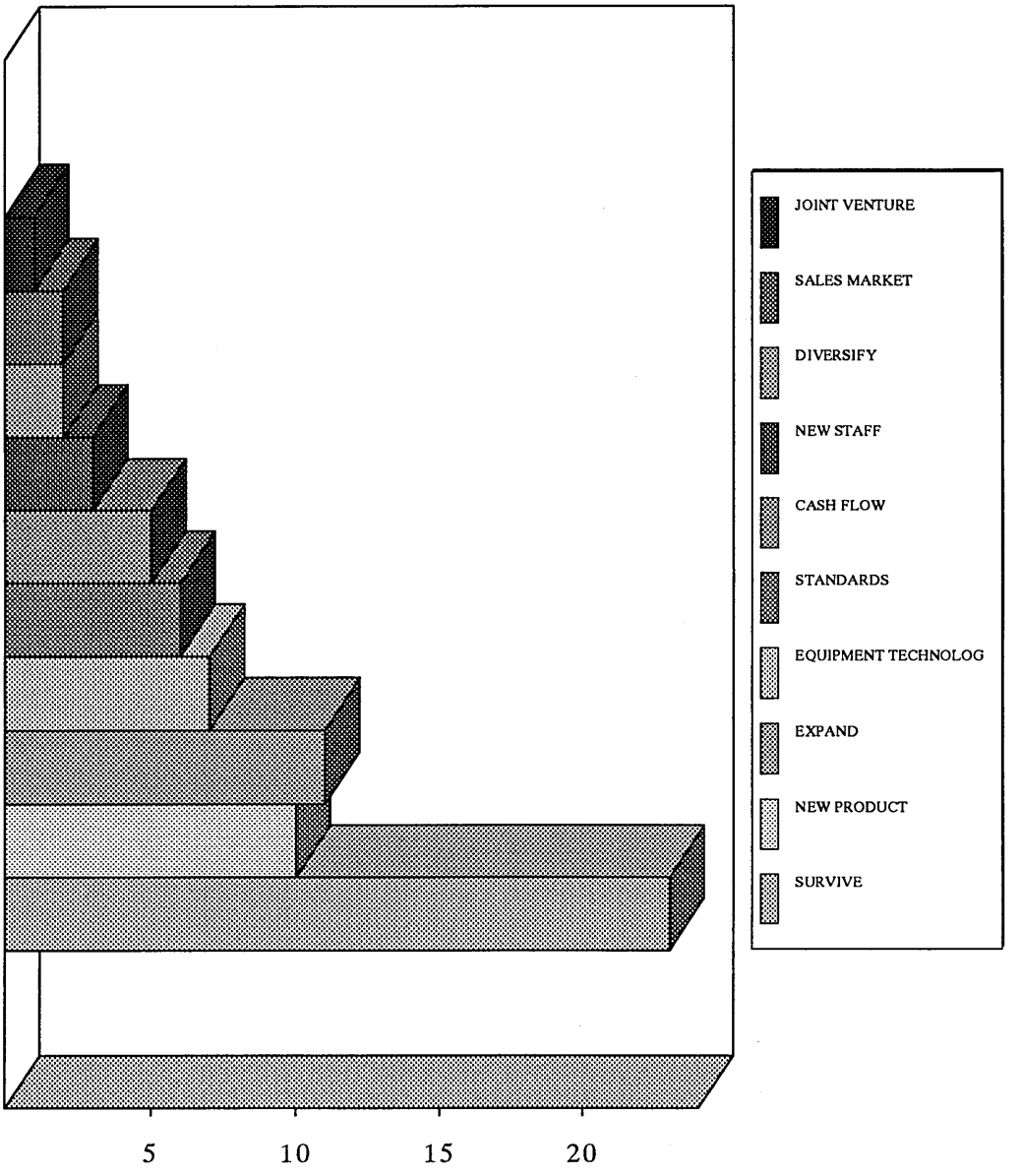
PLAN COMPANY	MAINTAIN EXISTING BUS SURVIVE	SOLVE CASH FLOW BANK OFF BACK	EXPANSION WHEN ECON PICKS UP	OBTAIN BS 5750	EQUIPMENT TECHNOLOGY	DIVERSIFY CUSTOMER BASE	NEW MANAGMENT STAFF	INTRODUCE NEW PRODUCTS	EXPAND SALES MARKETING	JOINT VENTURES LINKS	
AC	3	2									
AL	3		2					1			
BE	3				1	2		1			
BL							3		2		
BO			3	1	2						
BR	3				2						
CU	3							2			
DE	3		2					1			
GI			3		2			1			
MD	3			2				1			
WA	2	3	1					1			
WE				3				2		1	

Fig 5.2(x) ANALYSIS OF OBJECTIVES IN PLANS BY COMPANY (using weightings)

apparent. Most of the companies seemed to be anticipating some relief from recessionary pressures even though they admitted to not experiencing any real upturn at the time of the research. However this anticipation was leading to planning for expansion and as a result this also featured strongly in plans. The

Fig 5.2(y)

ANALYSIS OF MAIN OBJECTIVES IN PLANS FOR ALL COMPANIES
(USING SIMPLE WEIGHTINGS)



pressure to diversify and to introduce new/own products as a result of failing markets or major customers was another important element. The development or introduction of new products was mentioned as frequently by SMEs as surviving the recession but when ranked it was give a much lower priority (see Fig 5.2(y)).

Of particular interest within the plans of the SMEs in the sample is the relatively important emphasis given to the acquisition of new plant, machinery or technology. One simple logical explanation is that there is a progression anticipated in the plans - firstly survive until the recession ends, then expansion, introduction of new products and related machinery and technology and then attend to more individual elements of plans.

Complying with standards was identified as a problem by six companies in the sample - but only featured in plans of two of the original six. An indication perhaps that the other four hoped the problem would go away !

The more individual elements in the SMEs' plans are represented by plans to acquire new management staff, to increase sales and marketing effort to obtain work out of the Luton area, and to establish a joint venture for marketing a new product.

Another research question this time suggested by this analysis of SME plans (but not investigated in phase 2) is:

To what extent would the change in this profile over a period of time indicate a 'window of opportunity' for technology transfer to SMEs ?

It could, for example, be expected that, as the most immediate element of maintaining existing business and surviving the recession recedes in importance in the SME plans, their secondary plans to expand, develop new products and acquire equipment and technology, will come to the fore. Then as these secondary plans recede, the training of staff and other more individual elements of the plans may come to the fore (almost a Maslow type hierarchy for SMEs !).

5.2.4.2 REQUIREMENTS TO MEET OBJECTIVES

The requirements identified by the SMEs as necessary to achieve their objectives are summarised in Fig 5.2(z), and shown diagrammatically for all the SMEs in Fig 5.2(aa). SMEs were also asked to rank the importance of their requirements and Fig 5.2(ab) summarises these results using the simple weighting scheme. Fig 5.2(ac) expresses these results diagrammatically, again for all the SMEs. SMEs would seem to be perceiving the end to the recession (coupled to a return of business confidence) and access to appropriate finance as the key requirements necessary to achieve the main objectives of their business plans. Grants and/or loans are also identified by a considerable number of the SMEs, and rated highly as facilitating elements of their plans. The previously identified problem of declining markets or loss of major customers feeds through into both plans, and requirements to achieve plans. In a number of cases a plan to move to an own product range feeds through into a

COMPANY REQUIREMENT	AC	AL	BE	BL	BO	BR	CU	DE	GI	MD	WA	WE
Finance, Capital - Interest rates-easier borrowing, reform of					X		X	X	X		X	
End to recession - economic upturn action by government		X		X	X			X			X	
More highly skilled or qualified labour - reform of education			X	X				X	X			
New equipment - acquisition of plant, machinery, technology			X									
Diversify - develop own/new product		X	X							X		X
Maintain existing level of business										X		
Return of business confidence willingness to invest				X					X			X
Obtain approvals BS5750			X							X		X
Joint venture							X					X
Pick up in large companies												
Grants, assistance, starter units, help with rent and rates	X	X				X			X		X	
Miscellaneous other												

Fig 5.2(z) ANALYSIS OF REQUIREMENTS TO MEET OBJECTIVES OF PLAN

COMPANY REQUIREMENT	AC	AL	BE	BL	BO	BR	CU	DE	GI	MD	WA	WE
Finance, Capital - Interest rates-easier borrowing, reform of					3		3	2	2		3	
End to recession - economic upturn action by government		3		2	2			3			2	
More highly skilled or qualified labour - reform of education			1	1				1	1			
New equipment - acquisition of plant, machinery, technology			1									
Diversify - develop own/new product		1	3							1		1
Maintain existing level of business										3		
Return of business confidence willingness to invest				3					3			3
Obtain approvals BS5750			2							2		2
Joint venture							2					
Pick up in large companies												
Grants, assistance, starter units, help with rent and rates	3	2				3			1		1	
Miscellaneous other												

Fig 5.2(ab) ANALYSIS OF REQUIREMENTS TO MEET OBJECTIVES OF PLAN BY COMPANY (using simple weightings)

Fig 5.2(aa)
ANALYSIS OF REQUIREMENTS FOR PLANS FOR ALL COMPANIES
NUMBER OF COMPANIES IDENTIFYING EACH CATEGORY

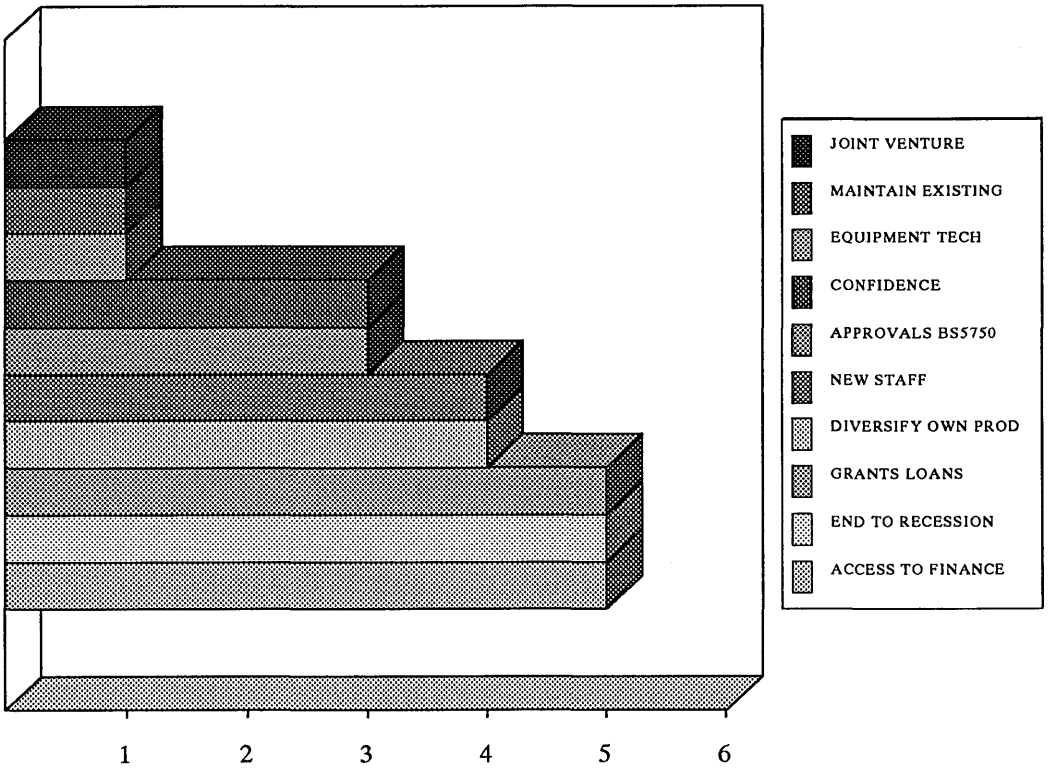
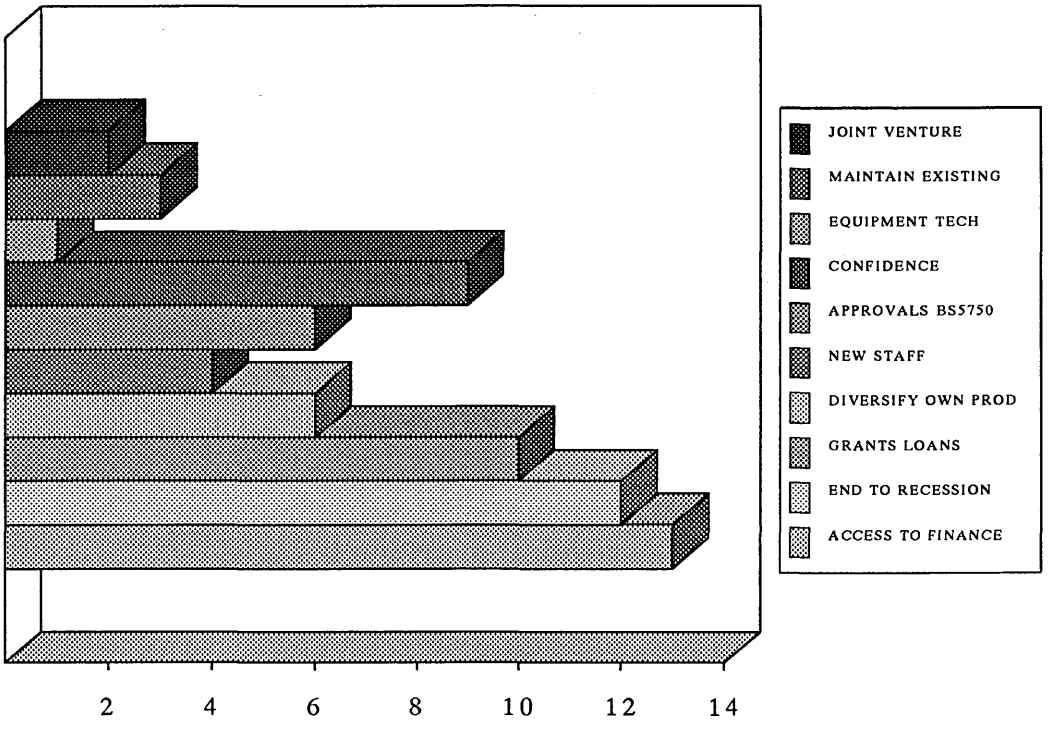


Fig 5.2(ac)
ANALYSIS OF REQUIREMENTS FOR PLANS FOR ALL COMPANIES
(USING SIMPLE WEIGHTINGS)



requirement to develop the product range. In other cases there is a plan for expansion or diversification, and the development of a new product is seen as a requirement for achieving that plan.

If the analysis of objectives in plans is compared with the analysis of requirements for plans then some interesting features can be noted. The objectives in the SMEs' plans most frequently encountered are:

1) to survive the recession
2) to plan for expansion (reversed with new products in weighted analysis)
3) to introduce new products
4) to acquire new equipment and technology.

The analysis of requirements for the achievement of plans shows that the SME plans (considered as a whole) seem to translate into most frequently encountered requirements for access to finance, an end to the recession and grants and loans. On consideration it would seem quite reasonable to assume that SMEs, concerned about the effects of the recession and plans for survival would perceive the more important of their requirements to be an end to the recession and suitable access to finance. However, of particular interest in the comparison, is that the SME plans for developing new products, expanding and acquiring new equipment or technology also do not seem to translate frequently into requirements for equipment or technology. Only one of the SMEs in the sample (BE) perceived technology as a requirement for his plan, and even then it was only rated third in order of importance.

On first consideration this appeared to be a most significant finding as it seemed to indicate that the SMEs in the sample did not, or were not able to, perceive their requirements, for achievement of the objectives of their plans, in terms of technology. However on reflection it would seem quite reasonable to assume that any SME planning to develop new products, expand, or acquire new equipment would initially have the requirement of access to finance or grants and loans BEFORE the requirement of the acquisition of the technology. In other words the research data can be seen as representing the perception of requirements at a particular point in time and could represent an ordering of requirements, not only in order of frequency and ranking of importance, but also, implicitly, to include an ordering of sequential steps to achieve any particular plan. For example it would be quite logical to consider that an SME with a plan to acquire new technology has a latent requirement to acquire that technology, but an actual or current requirement to obtain access to finance, or obtain a grant or a loan. Once the actual requirement for access to finance has been satisfied (and the money or loan becomes available) then the latent requirement to acquire the technology becomes an actual requirement. Clearly this argument is largely conjecture. All that can be said from the findings of the research is that, at the point in time when the research was conducted, the plans of the SMEs in the sample included significant elements of new product

development, expansion and acquisition of equipment and technology, however their perception of their requirements to achieve these objectives did not, at that same point in time, indicate a significant element of requirement to acquire equipment or technology.

CHAPTER 6

6. DESIGN OF INVESTIGATION - PHASE 3

6.1 BACKGROUND

The results from phase 2 of the research indicated that the SMEs in the sample generally did not perceive the acquisition or use of technology as a problem, nor did they generally perceive the acquisition or use of technology as a solution to problems, or as a means to achieve their plans. In terms of Receptivity, the SME's 'overall ability' to be aware of, to identify, and to take effective advantage of technology, could be considered as low because the SME did not perceive technology to be a solution to any of the SME's pressing problems or as a means to achieve the SME's plans. This statement implies that the motivation to be aware of, to identify and to take effective advantage plays an important role in the SME's 'overall ability' and perhaps an appropriate qualification of the concept of 'Receptivity' should include 'the overall motivation and ability'. Further consideration of this point will be made in the concluding chapter.

It was decided to mount a short third phase of the investigation to explore the findings from Stage 2. Two important areas of question had emerged

1) Were the SMEs not identifying technology as a solution to problems, or as a means to achieve plans, because they were unable to perceive a link between technology and their problems or plans ? Alternatively were the SMEs able to make the necessary links, and had therefore considered technology as an option, and then discarded it (or given it a poor rating) for some reason ?

This question could have important implications for policy, for in one case the links would have to made for the SME (or the SME helped to make the links), and in the other case the reasons for the discarding (or poor rating) would have to be addressed.

2) What, in either case, did the SMEs perceive as being required in order for them to consider technology as a valid option (or rate it more highly) ?

6.2 DEVELOPMENT OF PHASE 3

The design of phase 2 of the research was considered to be relatively successful. The interview schedule and the design of the data collection forms seemed to work well and the technique seemed to be effective in eliciting the problems and plans of the SMEs, and in obtaining a snapshot of their perceived solutions to problems, and means to achieve plans. Overall the approach seemed to be providing some insight into what may be going on

inside the SME, and as a result shedding some light on the original research questions.

Perhaps it should also be noted here that the SMEs were responding well to the investigation as an 'event'. Quite often the interviews would extend to a whole morning or afternoon and would conclude with a tour of the works and demonstrations of equipment and products. On a couple of occasions the owner/manager apologised for taking up so much time !

The initial design for stage three proposed that the researcher should return to the SMEs with an information pack containing a balanced range of literature covering the complete spectrum of types of assistance for small companies. This included information about financial assistance in the form of grants and loans, consultancy assistance via the Enterprise Initiative including help for BS5750, details of training schemes and allowances, and lists of information sources. In addition information was included about various innovation and technology schemes (SMART, SPUR). The researcher would then link the problems and plans of the SME (identified in phase 2) to a range of these measures, some of which would include technology. However there would be no specific focus on technology at this stage.

The researcher would then return to the SME some months later to see which options or sources had been pursued, or which of the options had been of particular interest, and why. It was hoped that this may generate data which would enable a comparison between problems and plans that had been linked to technology, and problems and plans that had been linked to the range of other options. It was considered that this may lead to some understanding about whether, if a link between a problem or a plan and technology was made for the SME, this would result in a change in the SME's perception of solutions to problems, or means to achieve plans.

The information pack was compiled and refereed for balance, and then piloted on a couple of the SMEs. It became immediately apparent that there was a serious problem with this approach. The problem stemmed from the (in retrospect rather stupid) assumption that the process of the interviewer linking options to the problems and plans of the SME would provide some useful and assessable feedback. However once the interviewer has made the linkages for the SME it then becomes difficult to assess, in any meaningful way, whether the SME would have been able or willing to make their own linkages. All that tended to happen was that the SME would feed back the linkages that had been made for them, and, without a number of further meetings, it would be difficult to determine whether the process of making the linkages had anything more than a temporary effect.

It was decided not to continue with this approach but to extend the phase 2 techniques and approach into phase 3, and a new interview schedule and data capture forms were drafted (see Appendix C).

6.3 DESIGN OF INTERVIEW SCHEDULE AND DATA CAPTURE FORM

The phase 3 interview schedule was designed to enable the following:

1) To draw the attention of the SME to the present concerns that small manufacturing companies were not considering or evaluating technology related alternatives (for example technical innovations in products or manufacturing processes) as a means of solving problems or achieving plans.
2) To then refresh in the owner/manager's mind the problems and plans identified in phase 2.
3) Then for each individual problem, and for the plan as a whole, to ask the owner/manager if he had identified, or could identify, any technology related options which linked to each problem or to his plan.
4) Then for each individual problem, and for the plan as a whole, to seek out the owner/manager's perception about what would be required in order for him to consider technology as a valid solution to each problem, or as a means to achieve his plan.
5) Finally to seek a simple ranking in order of all the identified requirements for each of the problems, and for the plan as a whole, in order to permit some assessment of relative importance.

The considerations upon which the design was based were the same considerations made in the preparation for phase 2. Again the wording of the schedule was designed to provide the minimum possible guidance as to any subsequent response. The data capture forms were set out so that they could be headed up with the problems and plans identified in phase 2, and then they could be used to capture the main points made by the SME in the same manner as the phase 2 data capture forms.

The decision to revert to the same techniques used in phase 2 was largely as a result of the success of phase 2. The techniques had been shown to be effective and the procedures for analysis of data had also been established.

As with phase 2 the data record sheets were studied and annotated and a categorisation of the data formulated. The sheets were then re-examined and the data classified into the identified categories. The presentation of the findings follows in the chapter.

CHAPTER 7

7. ANALYSIS OF DATA

The analysis of data began, as with phase 2, with the categorisation of the data and then the classification of the data into the identified categories.

7.1 CATEGORISATION OF DATA

7.1.1 CATEGORISATION OF PROBLEMS PERCEIVED BY SMEs

The existing categories from phase 2 for analysis of problems were employed.

7.1.2 CATEGORISATION OF REQUIREMENTS FOR TECHNOLOGY TO BE CONSIDERED AS A VALID OPTION

The SMEs were asked what they perceived as being required for technology (in all its forms) to be considered as a valid option for solution of problems or the achievement of plans. Responses were categorised as follows:

1) ACCESS TO FINANCE, CAPITAL, BORROWING. LOWER INTEREST RATES
This category included requirements identified as 'if had spare capital', 'need to solve cash flow problem', 'lower interest rates'

2) ADDITIONAL WORK,VOLUME OF WORK, FIRM OR REGULAR ORDERS
This was the most frequently identified requirement by the SMEs for technology to be considered. The category included 'if needed extra capacity', 'level of work would come first', 'lot more work or major contract', 'larger volume of business', 'definite orders'

3) MORE HIGHLY SKILLED OR QUALIFIED LABOUR
This requirement was identified by one SME as 'would need necessary skills to be able to deploy'

4) RELIABILITY/RECOMMENDATION
This category included references to 'recommendation from others in business', 'tried and tested technology - reliability very important'

5) RETURN OF BUSINESS CONFIDENCE/WILLINGNESS TO INVEST
References to 'confidence in return on investment', 'confidence to return to investing', 'business confidence' were included in this category.

6) TECHNICAL SUPPORT
This category included references to 'suppliers expertise' and 'technical back up'

7) ADVICE, HELP, INFORMATION
References to 'more information to assist in using', 'would need to investigate' were included in this category.

8) LEGISLATION/ EXTERNAL PRESSURE
This requirement was only identified by one SME and was in connection with the problem the business was encountering with complying with environmental legislation. The SME would consider the acquisition of technology 'dependant on the pressure of legislation (enforcement of)'.

9) GRANTS, GOVERNMENT ASSISTANCE, TAX INCENTIVES
This category included references to '200% capital allowances', 'grants would help'.

10) MISCELLANEOUS
This category was for all other references not falling within the categories above. In fact only one item fell into this category 'would have to see definite benefits in terms of time saved on job'.

7.2 PRESENTATION OF FINDINGS

7.2.1 SAMPLE FOR PHASE 3

The sample for phase 3 consisted of the 8 companies remaining from the original sample plus an additional 2 companies (WA and WE).

7.2.2 ANALYSIS OF LINKS BETWEEN TECHNOLOGY AND PROBLEMS

The analysis of the companies who perceived a link between their problems and the acquisition of new technology is shown in Fig 7.2(a) The analysis presents a rather mixed picture. Certainly there would seem to be certain types of problem, for example, access to finance, improvement of cash flow, where the SMEs did not perceive a link with the acquisition of technology. There is, of course, no immediately obvious link, and possibly the acquisition of technology could even be considered as an option which would only exacerbate any financial problems. It could however be argued , for example , particularly in the case of improving cash flow, that the acquisition of technology could help to reduce manufacturing costs, leading to higher profit margins, and as a result, easing the cash flow situation. However whether

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PROBLEM COMPANY	VOLUME OF BUSINESS NEED MORE B	ACCESS TO FINANCE	OBTAIN SKILLED LABOUR	COMPLY LEGISLN & BS 5750	NEED TO CUT COSTS	BROADEN CUSTOMER BASE	CASH FLOW	NEW/OWN PRODUCTS	RENT AND RATES	EQUIPMENT TECHNOLOGY	
AC	Y	N					N				
AL				Y							
BL	Y		Y								
BO	Y	N					N				
BR				Y						Y	
CU	I							I			
GI	I		N					N			
MD				N			N	I/Y	N		
WA	I			N			N				
WE		N		N		I					

Y - Link perceived N - No link perceived I - Link perceived to inhouse technology

Fig 7.2 (a) ANALYSIS OF PERCEIVED LINKS BETWEEN TECHNOLOGY AND PROBLEMS

it would be reasonable to assume that this rather complicated chain would materialise in the interview situation is another matter.

There would also seem to be other problems where the SMEs had no difficulty in linking to technology. In the case of the volume of business problem all the SMEs volunteered links between the problem and technology, although as can be seen from the analysis, half of the companies linked the problem to the use or development of their own, in house resources. Three of the SMEs linked this problem to external technology.

Under the category of complying with standards two of the companies (AL and BR) had identified a problem with complying with environmental standards. One of the companies needed to reduce emissions from a small furnace, and the other needed to reduce the dust in the working areas generated by various presswork activities. For both these companies the acquisition of new technology (or discontinuing the process) was seen as the only solution of the problem. In both cases the link between the problem and specific items of technology had been made as a result of their contact with the environmental health officers charged with ensuring compliance with standards.

One of the SMEs (BL) posed a problem in that the company had identified a problem with obtaining appropriately trained labour. When asked if there was a perceived link between the problem and technology, the response concerned the content and quality of the local training courses that the SME used. However the reply was essentially about the technology content of the courses and provided a clear link to technology through the acquisition of skills provided by the training courses.

One of the SMEs (MD) identified both internal and external technology in links to his problem about developing his own products, and as a result both categories, in house and external, are shown on the table (Fig 7.2(a))

7.2.3 ANALYSIS OF REQUIREMENTS FOR TECHNOLOGY TO BE CONSIDERED AS A VALID OPTION FOR SOLUTION OF PROBLEMS

The analysis of the requirements identified by the SMEs for them to consider technology as a valid solution to problems is shown in Fig 7.2(b). The table reflects the fact that, for a number of the problems, technology was not seen as being relevant to the problem (hence there are no entries under four of the identified problems). For the problems where technology was considered relevant it can be seen that the SMEs perceived access to finance, and additional work in terms of firm or regular orders, as particularly important. A return of business confidence was connected to an end of the recession and a pick up in the volume of work, and so can be seen as also being related.

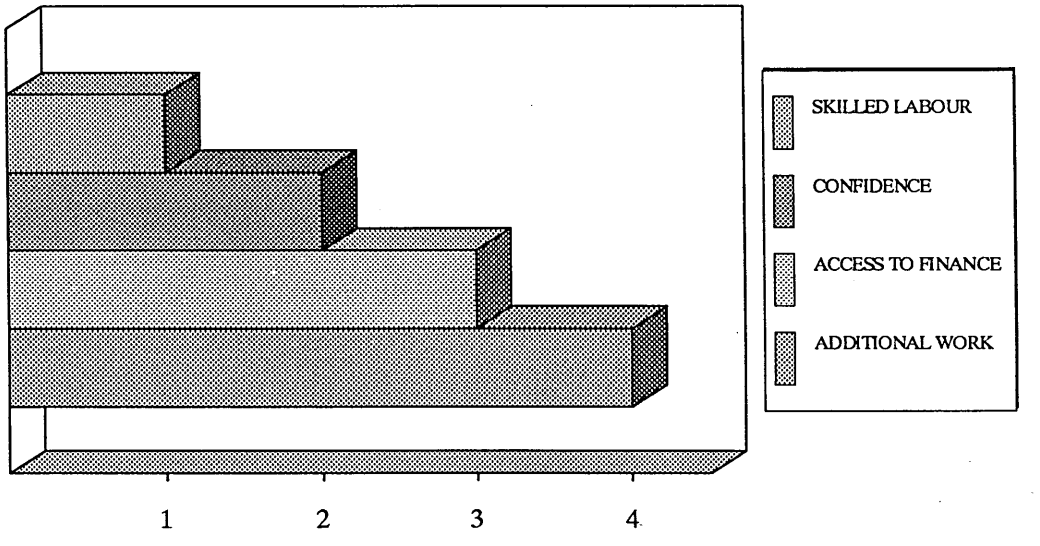
PROBLEM REQUIREMENT	VOLUME OF BUSINESS NEED MORE B	ACCESS TO FINANCE	OBTAIN SKILLED LABOUR	COMPLY LEGISLN & BS 5750	NEED TO CUT COSTS	BROADEN CUSTOMER BASE	CASH FLOW	NEW/OWN PRODUCTS	RENT AND RATES	EQUIPMENT TECHNOLOGY
Access to finance, capital - Interest rates- easier borrowing	3(AC)2(BO) 2(WA)			2(AL)3(BR)				2(MD)		3(BR)
Additional work, volume of work, firm orders	2(AC)3(BO) 3(WA)3(BL)		3(BL)					3(MD)		
More highly skilled or qualified labour - reform of education system	2(BL)									
Reliability/recommendation										
Return of business confidence willingness to invest	1(BL)1(BO)		2(BL)							
Technical support				1(AL)						
Advice Help information				3(BR)						
Legislation, external pressure				3(AL)						
Grants, assistance, tax incentives						3(WE)				2(BR)
Miscellaneous other										

Fig 7.2 (b) PERCEIVED REQUIREMENTS FOR TECHNOLOGY TO BE CONSIDERED AS A VALID SOLUTION TO PROBLEMS - ANALYSIS BY PROBLEM USING SIMPLE WEIGHTINGS

Again what is not clear is the extent to which the requirement for additional work or access to finance are requirements which would have to be satisfied before the SME would actively start to consider technology. In addition there exists a rather strange circular argument that the SMEs did not seem to be aware of. Their identified problem was a shortage of business and yet their requirement for technology to be considered as a valid solution was additional work, regular orders and contracts.

It is now possible to consider each of the categories of problem with respect to the perceived requirements. Most of the data can be visualised from Fig 7.2(b) as it relates to individual companies, however it is useful to examine the

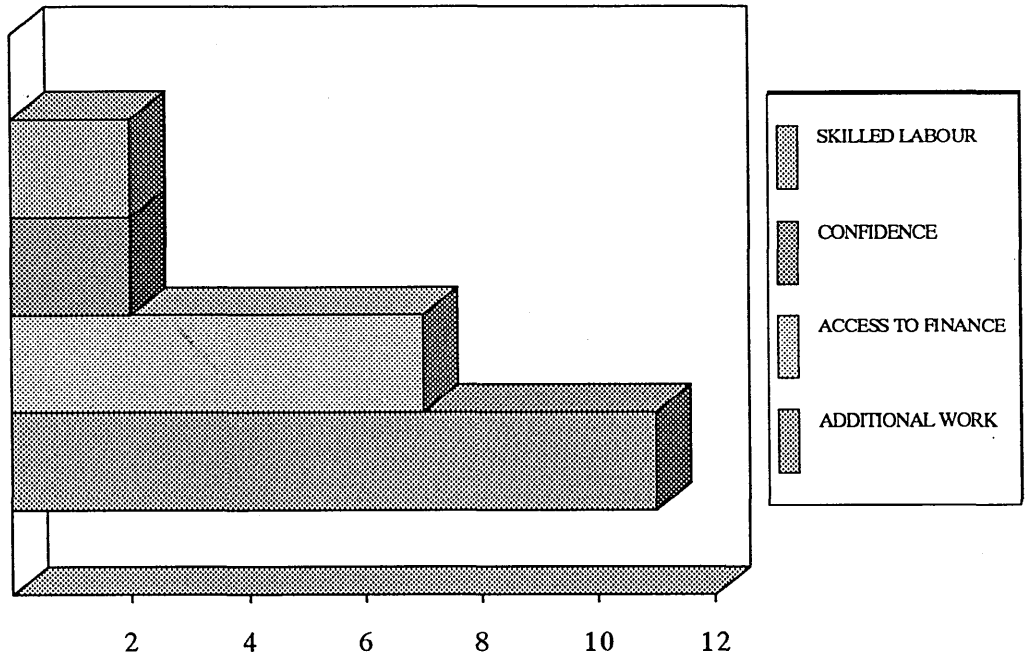
Fig 7.2(c) REQUIREMENTS FOR TECHNOLOGY TO BE CONSIDERED AS A SOLUTION TO OBTAINING MORE WORK



problem of obtaining more work diagrammatically in Figs 7.2(c) and 7.2(d). As can be seen from the bar charts one of the main requirements for technology to be considered as a solution to the problem of obtaining more work, is more work ! There was however another element that was often injected by the SME and that was that the type of work required was regular work. If the SME could be assured of a regular flow of work then this would enable the consideration of technology to become a valid option.

The problem of obtaining skilled labour was mentioned earlier in this chapter, where the SME in question saw training as the appropriate route to acquire his technology. He indicated that a return of confidence, coupled to additional work, would persuade him to undertake additional training.

Fig 7.2(d) REQUIREMENTS FOR TECHNOLOGY TO BE CONSIDERED AS A SOLUTION TO OBTAINING MORE WORK



EXPRESSED USING SIMPLE WEIGHTINGS

The problem of complying with environmental legislation concerned two of the SMEs, and access to finance (being able to afford environmental monitoring
and cleaning technology), pressure of the enactment of the legislation, technical support and independent advice were the requirements for technology to be considered as a valid option.

A single company (WE), facing the problem of diversifying following a decline in the aerospace market, identified 200% capital allowances as his perceived requirement.

Another single company (MD) had identified development of own products as a problem, and identified access to finance new machinery and regular orders as his perceived requirements.

Finally another single SME (BR) had identified a problem with the acquisition of new equipment and he identified suitable finance or a government grant as his requirements.

7.2.4 ANALYSIS OF LINKS BETWEEN TECHNOLOGY AND PLANS

The analysis of the companies who perceived links between technology and the achievement of their plans is shown in Fig 7.2(e). The figure shows the objectives identified by the SMEs as elements of their plan and then in the end column is the record of whether the SME perceived a link between the plan as a whole and technology as a means to achieve the plan. One of the weaknesses identified with the design of this phase of the research is that the SMEs were only asked to link their plan as a whole, and it is anticipated that if the linking had been done with the individual objectives of the plan it may have been possible to carry out a more detailed and interesting analysis.

What the data does show, however, is that there was strong linking between the plans of the SMEs and either internal or external technology, with only one of the SMEs in the sample not perceiving a link between his plan and technology as a means to achieve it. This finding tends to re-inforce the earlier findings that SMEs tend to link their plans much more strongly to a perception of technology as a means to achieve plans than they link their problems to a perception of technology as a means of solving problems. One simple explanation would be that problems are immediate, and have to be solved within the constraints that the SME feels are 'real' at that point in time (e.g. level of work, access to finance). On the other hand discussion of a plan involves a longer term perspective and elements of 'wish factor' for the future - 'if new project goes to volume then it may be necessary to consider CNC'.

Findings of this type tend, on reflection, to appear to be common sense and of no particular importance, however there would appear to have been a lot of time and money spent on surveys of SMEs which seek expression of SME plans, and then assume that the SMEs perceive an immediate need for technology to solve their problems.

7.2.5 ANALYSIS OF REQUIREMENTS FOR TECHNOLOGY TO BE CONSIDERED FOR ACHIEVEMENT OF PLANS

The final section of analysis of the phase 3 data consists of the analysis of the perceived requirements for technology to be considered as a valid option for the achievement of the SMEs plans. A summary of the findings is given in Fig 7.2(f). The table shows not only the requirements identified, but also shows the simple weighting allocated to reflect the relative importance indicated by the SMEs as a result of their ranking of the requirements. This data is also represented graphically on the two bar charts below (Fig 7.2(g) and 7.2(h)).

PLAN / COMPANY	MAINTAIN EXISTING BUS SURVIVE	SOLVE CASH FLOW BANK OFF BACK	EXPANSION WHEN ECON PICKS UP	OBTAIN BS 5750	EQUIPMENT TECHNOLOGY	DIVERSIFY CUSTOMER BASE	NEW MANAGMENT STAFF	INTRODUCE NEW PRODUCTS	EXPAND SALES MARKETING	JOINT VENTURES LINKS	LINK
AC	X	X									N
AL	X		X					X			Y
BL							X		X		I
BO			X	X	X						Y
BR	X				X						Y
CU	X							X			I
GI			X		X			X			Y
MD	X			X				X			I
WA	X	X	X					X			I
WE				X				X		I	I

Y - Link perceived N - No link perceived I - Link perceived to inhouse technology

Fig 7.2(e) ANALYSIS OF PERCEIVED LINKS BETWEEN TECHNOLOGY AND PLANS

COMPANY REQUIREMENT	AC	AL	BL	BO	BR	CU	GI	MD	WA	WE
Access to finance, capital - Interest rates- easier borrowing	3	3		1				2		2
Additional work, volume of work, firm orders		1	3	3	3			3	3	3
More highly skilled or qualified labour - reform of education system										
Reliability/recommendation					2		3			
Return of business confidence willingness to invest		2								
Technical support							2			
Advice Help information							1			
Legislation, external pressure										
Grants, assistance, tax incentives				2						
Miscellaneous other	2									

Fig 7.2(f) ANALYSIS OF REQUIREMENTS FOR TECHNOLOGY TO BE CONSIDERED AS A VALID OPTION FOR ACHIEVEMENT OF SME PLANS (SIMPLE WEIGHTINGS SHOWN)

Fig 7.2(g) REQUIREMENTS FOR TECHNOLOGY TO BE CONSIDERED AS A VALID OPTION FOR ACHIEVEMENT OF PLANS
NUMBER OF COMPANIES IDENTIFYING EACH CATEGORY

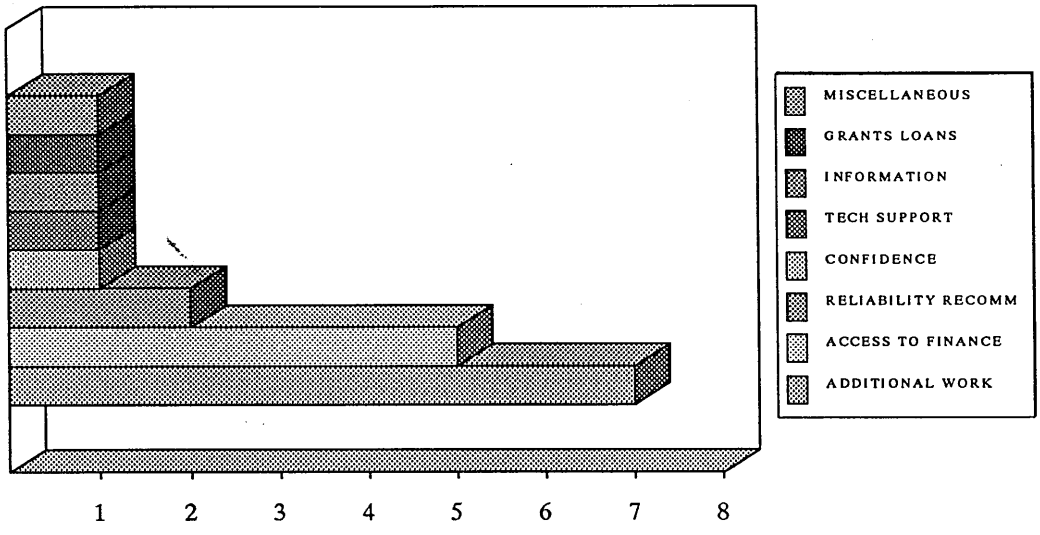
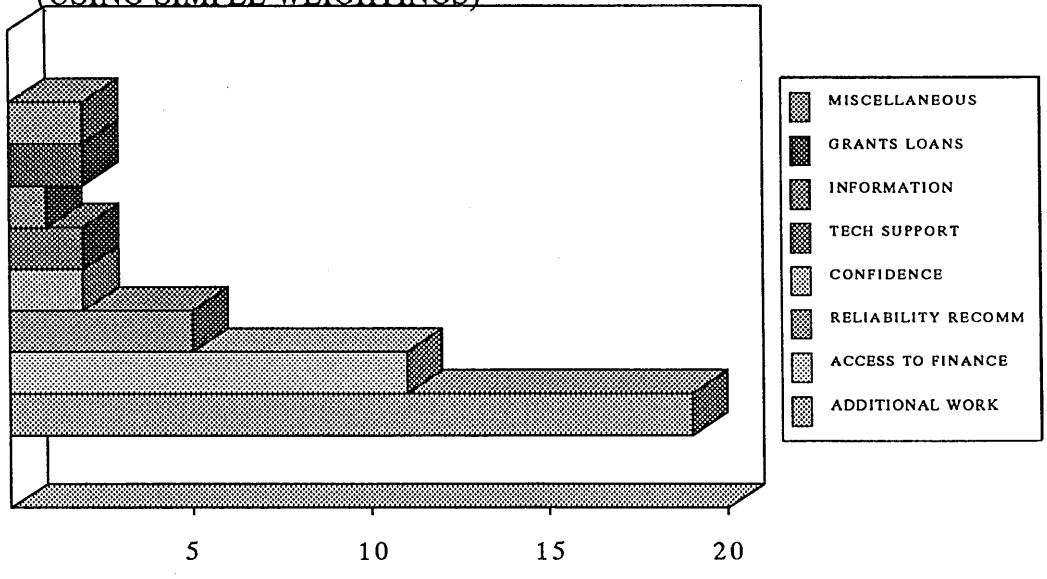


Fig 7.2(h) REQUIREMENTS FOR TECHNOLOGY TO BE CONSIDERED AS A VALID OPTION FOR ACHIEVEMENT OF PLANS
(USING SIMPLE WEIGHTINGS)



Recommendation by other businesses and tried and tested reliability were requirements identified by two of the SMEs. All the rest of the requirements identified represented the individual requirements of single SMEs.

CHAPTER 8

8. DISCUSSION AND CONCLUSIONS

The final chapter of this thesis is divided into two sections. The first section draws conclusions from the analysis of the field research. The second section discusses the findings and considers the implications for future research and for policy.

8.1 CONCLUSIONS

The first informal phase of the research confirmed the 'Hausner Paradox' in that the SMEs involved in the investigation responded positively to questions about technology and technology transfer. However, faced with the opportunity to participate in the technology process, or to make use of technology transfer services, they were failing to do so.

The second phase of the research was designed to elicit from the owners/managing directors of a small sample of engineering SMEs, their perception of the main problems that they were encountering, and the main elements of their future plans for the business. The research was then designed to explore what the owner/managing director perceived as being necessary to solve the problems that they had identified, and also to achieve the plans that they had mapped out.

The research, conducted during 1991-93, found that these SMEs did not generally perceive the use, or acquisition of technology as a problem (only one company in the sample citing a very specific equipment related problem). The SMEs also did not generally perceive the use or acquisition of technology as a solution to the problems that they identified.

In contrast the research found that the SMEs did perceive the acquisition and use of technology as an important element in their plans for the future of the business, in conjunction with other technology related plans (introduction of new products and expansion of the business). However, perhaps the most interesting finding was that this element of the SMEs plans did not translate into a perceived need to use or acquire technology. The SMEs in the sample did not perceive the use and acquisition of technology as a requirement to achieve the objectives of their plans.

The third phase of the research was designed to assess whether the SMEs (through the eyes of their owner/directors) were able to link the use and acquisition of technology to their problems and plans. The findings of the research were far less well defined here. Generally the SMEs in the sample did appear to be able to make links between their problems and plans and either

internal or external technology, although particular types of problem were not linked to any form of technology. It is not clear whether this was due to the interview situation concentrating thoughts on the immediately perceived links or whether, if the owner/directors pursued a more complex train of thought, they would also be able to link these problems.

Finally the third phase of the research was designed to explore what the SMEs perceived as being their requirements for the acquisition and use of technology to be considered as a solution to their problems, or as a means to achieve their plans. The findings indicate that the SMEs in the sample perceived the ability to access suitable finance, the securing of additional or regular work, and a return of business confidence, as their key requirements.

In addition to the specific conclusions above there were some general conclusions that could be drawn about the SMEs in the sample under each main section of the field research.

SME PROBLEMS

At the time of the research many of the SMEs' problems stemmed from the recession. Problems with a generally low level of work linked to concerns about cash flow, the need to cut costs, and the need to diversify out of declining markets formed a batch of recession related problems of most concern. The other main problem was identified as relating to the pressure on SMEs to conform to the environmental and quality standards.

IDENTIFIED SOLUTIONS

Perceived solutions were largely external to the SME and focused on an end to the recession and access to suitable finance to keep the business going pending the end to the recession. The problem of conforming to standards was addressed by solutions which would tone down, or defer the need for compliance.

SME PLANS

The SMEs plans were also very much influenced by the recession, with survival of the recession a major element in most plans. However there also seemed to be anticipation of an end to the recession, and a strong element of expansionary activity', including the development of new or own products, and acquisition of equipment and technology, was also present in their plans.

REQUIREMENTS TO ACHIEVE OBJECTIVES OF PLANS

Identified requirements were again largely external to the SME, and again focused on an end to the recession, a return of confidence, and an ability to access suitable sources of finance, or grants and loans, to keep the business going. The declining local market for engineering led to requirements for diversification and the need to obtain approvals was a requirement in response to pressure to conform to standards.

8.2 INTERPRETATION OF CONCLUSIONS

The conclusions above can be considered to be the 'hard' conclusions from the research. It now becomes possible to consider the interpretation of the conclusions and to suggest, on the basis of the evidence, what would appear to be the implications. Perhaps these could be seen as the 'softer' conclusions.

8.2.1 HAUSNER REVISITED

Phase 1 and phase 2 would appear to verify earlier positivistic research, to the extent that any approach to the SMEs in the sample, seeking out elements of their plans for the future, would encounter plans for expansion, the introduction of new products, and acquisition and use of technology. Assumptions about SMEs perceiving the importance of technology, and then the need for technology transfer services, based on helping SMEs to access available technology, would tend to follow.

This research, however, would seem to indicate that these assumptions cannot be made. The SMEs in the sample, at the time of the research, generally did not perceive the acquisition and use of technology to be problem, nor did they perceive it as a solution to other problems, nor as a means to achieve their plans. In short there would appear, from the SMEs viewpoint, to be no immediate reason or motivation to acquire and use additional technology. The SMEs had no need to have increased access to available technology and no motivation, therefore, to use the services of intermediaries facilitating this access. This research would, therefore, seem to offer one explanation of the so called 'Hausner Paradox' and the problems faced by technology transfer intermediaries.

8.2.2 PUSH PULL REVISITED

Another of the issues of concern, in connection with technology transfer to SMEs, is that neither technology push nor demand pull approaches seemed to be leading to a satisfactory level of technology transfer activity. Technology transfer intermediaries (including the ERTC) have attempted technology push activities typified by construction of databases, or listings of technology for

license or transfer, and then tried to use these information sources as a means of marketing technology to SMEs. Alternatively, demand pull approaches focusing on the 'needs' of the SME have been undertaken, typically by conducting a survey or interrogative interview in order to 'discover' technology requirements from the 'marketplace'. The findings of the survey or interview are then used as the basis for searching out appropriate technology.

The earlier literature search provided evidence of a range of factors which need to be taken into account when considering this problem. Previous researchers have established that access to external technology and know-how had not been found to be a significant barrier to growth in manufacturing SMEs (Rothwell and Beesley, 1989). There is, however, considerable evidence of a whole host of internal problems and deficiencies that would inhibit SME's propensity and ability to articulate demand for, and to make use of, available technology. Poor management skills, inability to undertake strategic planning, and serious problems with access to financial and human resources, were some identified in the ACARD study (Barber et al, 1989).

The assumption behind both technology push and demand pull approaches to technology transfer would seem to be the Receptivity of the SME. In the case of technology push activity there is the assumption that SMEs perceive a need to acquire and use technology, and in demand pull approaches there is an assumption that the SME can express needs in terms of technology. This research would indicate that, amongst the SMEs in the research sample, the 'needs' of the SMEs, as embodied in their requirements to solve their problems or achieve their plans, did not translate into a perceived need to acquire or use technology.

8.2.3 RECEPTIVITY REVISITED

It became apparent during the research that the concept of Receptivity may be better considered as two separate elements, a set of 'latent' abilities and also a motivational element which mobilises or activates those abilities. Thus an SME may have an overall ability to be aware of, to identify, and to take effective advantage of technology. The staff within the SME may have all the necessary skills, education, external links etc. to enable them to scan for technology and to identify appropriate technology for their business. The SME may also have the human, technical, organisational and financial resources to be able to deploy and take effective advantage of the technology. The missing element is the motivational push to activate this latent ability. This thesis suggests that the problems and plans of the SME would seem to be key determinants of this motivational push. If an SME, at a particular point in time, does not perceive the acquisition or use of technology as a solution to a problem, or as a means to achieve a plan, then there will be no motivational push to use whatever 'overall ability' the SME has, to scan for, identify, or deploy technology.

In practice there will be a great variation in these 'latent' abilities, and the field research and the literature survey both indicate that SMEs are likely to encounter many barriers, human, technical, organisational, managerial and financial, which will limit their overall ability to scan for, identify or deploy appropriate technology.

If this approach to Receptivity is adopted, the ' overall abilities' of the SME can be mentally disentangled from the motivational push to use those abilities. The motivational push then becomes a determining element within concept of Receptivity. There must be the motivating 'pressure' not only to mobilise the 'overall abilities' of the SME, but also to provide the necessary impetus for the SME to want to change, build or restructure those internal abilities.

8.2.4 IMPLICATIONS FOR POLICY

This research would seem to suggest that, if there is a requirement for an improvement in the process of technology transfer to SMEs, the problems and plans of SMEs must, in some way, be articulated to the need to acquire and use, new or improved technology. The SMEs must be able to perceive technology as a means to solve ***their*** problems or to achieve ***their*** plans.

One of the implications for policy, if this statement is accepted, is that in order for policy to influence the articulation of the problems and plans of SMEs to a need for technology, it becomes necessary to know what those problems and plans are. What is not clear from this study is how far the problems and plans of SMEs can be generalised, and the extent to which each SME would have to be treated as an individual case. The research would also seem to confirm that increasing the flow of information about technology, or creating greater access to available technology will not in itself have any real effect (this re-inforces the findings of Rothwell and Beesley, 1989) and this has implications for all technology transfer intermediaries and new policy initiatives (e.g. the One Stop Shop programme).

This research did not investigate methods and means to articulate the problems and plans of SMEs to the need to acquire and use technology. However the research does indicate that future research leading to the solution of this problem is key to developing policy for successful technology transfer to SMEs.

It may well be that there are useful lessons to be learnt from the techniques of high tech marketing where exponents have become practised in selling technology as a package of customer benefits. Also the role identified by Rogers (1983) for the 'change agent' would seem to offer an approach which could be assessed.

8.3 PROPOSITIONAL FINDINGS

In research of this type there are often propositions which are suggested by the research, but which have an increasing subjective component. Often they cannot be justified in a conclusions section because the propositions are not firmly rooted in the data generated by the study. However propositions suggested by the data can be of interest, and can provide food for thought for other researchers. The following section covers these propositional findings.

Of particular interest in this section are propositions offering some explanation as to why future plans of SMEs to expand, develop new products and acquire related technology may not be translating into perceived requirements for acquisition of technology.

8.3.1 MASLOW REVISITED

In the analysis of the plans of the SMEs in the sample, the data suggested a possibility of a Maslow type hierarchy operating within SMEs. This proposition seemed an interesting one to discuss in this section.

Maslow(1970) postulated that man has five classes of 'basic needs'. At the first level is a need to survive, to satisfy the physiological needs for food, water and the pre-requisites of life. The second level involves the building of resources, a need for safety, security and avoidance of danger. The third level involves social needs and development as a social being. The fourth level involves individual needs, a need for esteem, a desire for self respect. Then finally the fifth level, Maslow proposed, was the need for 'self actualisation'. Maslow argued that these needs form a hierarchy with 'self actualisation' at the top and survival at the bottom. The lower order needs had to be satisfied first, and then once they had been satisfied to an acceptable degree the higher order needs came into play.

The analysis of the plans of the SMEs seemed to present a picture of small companies pre-occupied with the effects of the recession and surviving. However the analysis also indicated plans to introduce new products, to expand and to acquire and use new technology. When the owner/director rated plans by simple ranking, the order inevitably was to survive the recession, to re-establish financial stability, and then to think about new products, expansion and any related technology. Finally certain more individual elements emerged as more long term plans.

If the analogy with Maslow is pursued, the SME could be considered to have a hierarchy of need. At the first level is the survival of the recession, at the second level is the financial stability of the business (some security - return of confidence), then at a third level, general development of the business

(expansion, new products, related technology) with more individual developments occurring at even higher levels. If the analysis of requirements for the achievement of plans (Fig 6.4(f) and 6.4(h)) is examined, the perceived needs, at the time of the research, seem to be heavily focused on access to finance, grants and loans, and an end to the recession. These could all be considered as requirements to satisfy the basic level of need, the survival of the SME. Perhaps, again in the spirit of Maslow, only when the first level needs have been reasonably satisfied will higher order needs become actual needs.

8.3.2 EXTERNALISATION REVISITED

In the analysis of perceived solutions to problems one of the re-occuring themes was that of the SMEs externalising the solutions (i.e. identifying solutions which exist outside the SME). To a certain extent this could be anticipated, as to admit that the solution exists within the SME is to admit a form of failure (as the owner/directors is expected to have control over available solutions within the business). In the same way the causes of problems were largely externalised. This, however, raises an important consideration about whether technology is considered to be external to the business (and therefore a legitimate 'external' solution available for identification) or whether technology is considered internal (or even as one of the SMEs remarked 'Engineering is technology' implying that the business was technology). Many of the SMEs, when pressed to link technology to problems or plans, replied rather defensively in terms of the quality of the in-house technology being appropriate for their type of business.

The SMEs in the sample did not perceive the acquisition of technology as a problem, and it would seem reasonable to consider that this may be because owner/managers believe that their special skills, their special understanding of their business, would enable then to acquire and deploy any appropriate technology without the selection and acquisition of the technology per se being a problem. The 'real' problem about acquisition of technology being seen as the acquisition of appropriate finance.

8.3.3 AMR REVISITED

Examination of the ideas behind the evolution of the AMR framework can, it is proposed, lead to a number of interpretations. The one proposed in this thesis is that the AMR framework can be seen as proposing, conceptually, the 'characteristics' of sources of technology, recipients of technology, and the channels which connect them, that need to be present for technology transfer to occur. A source of technology has to exhibit the characteristic of Accessibility, the recipient has to exhibit the characteristic of Receptivity, and the channel the characteristic of Mobility. If a source of technology exhibits Accessibility (the technology is available and accessible), and the channel exhibits Mobility (an

appropriate channel is operational), and the recipient is Receptive (ready willing and able to articulate demand and to acquire and deploy), then technology transfer can occur. The framework implies that if these characteristics of sources, channels and recipients are present then technology transfer is enabled.

If the earlier discussion about Receptivity is accepted then it would appear that a useful addition to the AMR framework may be that of the concept of the magnitude, or extent of Accessibility, Mobility and Receptivity. The use of the framework, in the analysis of any particular situation may then be extended to cover not only the presence of the characteristics as enabling technology transfer, but also some measure of the characteristic. In the case, for example, of the concept of Receptivity there would seem to be certain observable characteristics of an SME which would indicate the extent of the latent Receptivity of the organisation (e.g. educational level of owner/director, employment of QSEs, financial status). It may then be possible to consider the framework evolving into an operational tool of analysis.

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APPENDIX A

BACKGROUND TO THE ERTC

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Introduction

The ERTC is part of a national network of Regional Technology Centres set up to encourage business to adopt new & improved technology and industrial best practice. The ERTC operates across the counties of Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Norfolk & Suffolk.

It aims to develop commercial partnerships between local education, research & business interests dedicated to increasing efficiency, competitiveness & profitability through the successful application of appropriate technology.

The ERTC is a company limited by guarantee, with its head office at Abington Hall, just south of Cambridge. The site has excellent facilities, including a fully equipped lecture theatre, on-site catering, technical library, printing, publishing, photographic studios & a video production unit.

ERTC satellite offices have opened in Bedfordshire, Hertfordshire, Norfolk & Suffolk: an office for Essex is planned for mid-1991. A partnership agreement has been signed with St John's Innovation Centre, Cambridge, to promote joint activities.

Offices are situated & manned appropriately to satisfy the local demand for services. In this way, access is good and the existing networks between industry & academe can be used & built upon. Seconded staff, on a full or part-time basis, are sought from academic & business partners to help provide specialist services.

The UK government provides a "pump priming" grant for the first three years, conditional on the provision of matching support, in cash or in "kind", from industry, commerce, academe & local government.

The Board of the ERTC includes representatives from industry & commerce, from educational institutions and from county councils. The government departments providing funding are represented. Because the Board is large, it has delegated substantial powers to an Executive Committee of directors. This meets more frequently than the Board, and is more closely involved in the day-to-day activities of the business.

Founder Members have come from among those organisations that had shown real interest in forming an RTC in the region. Founder Membership was open to those willing to pledge to provide the Centre with substantial resources, for a minimum of two years. Each Founder Member nominated a director for appointment to the Board, to hold office until the 1992 Annual General Meeting.

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The following organisations are Founder Members:

- Barclays Bank
- Bedfordshire County Council
- British Gas (Eastern)
- Cambridgeshire County Council
- Digital Equipment Co.
- Eastern Electricity
- Ernst & Young
- Essex County Council
- Hatfield Polytechnic (*the site of the Hertfordshire office*)
- Hunting Engineering
- Luton College of Higher Education (*the site of the Bedfordshire office*)
- Mills & Reeve
- National Westminster Bank
- Norfolk County Council
- Suffolk College (*the site of the Suffolk office*)
- Suffolk County Council
- University of Cambridge
- University of East Anglia (*the site of the Norfolk office*)
- University of Essex
- TWI (*the site of the Cambridgeshire office*)

Charter Membership is available now, to organisations wishing to make a similar contribution to that made previously by Founder Members. Charter Members will have the right to nominate a director to the Board of the ERTC, for the period of their support.

There is one other membership grade, namely the Ordinary Member, each of whom pays an annual subscription linked to the turnover of their enterprise. (A subscription has been set for non-trading organisations.) Ordinary Members have full voting rights.

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Typically, they are likely to be active in:

- the manufacture or supply of goods, components or materials,
- research, development or design of manufactured goods, components, materials, instruments, advanced machines or advanced tools,
- pure or applied scientific research,
- biotechnology, information technology,
- appropriate support, consultancy or business services associated with the above.

The ERTC seeks sponsorship, in cash or in "kind", if it can be directed towards specific activities or services that are broadly in line with sponsors' own business objectives.

Objectives

The Centre is the self-financing, regional focus for the provision of a wide range of technology transfer services.

More specifically the objectives of the Centre are:

- To provide easy local access to technology transfer services through a network of offices across the region.
- To use this network to increase the interest of industry in the use of available technologies. Particularly, to help industry to become more competitive, more efficient and, therefore, more profitable through awareness of the benefits of the application of technologies that are appropriate to their businesses.
- To help academe focus its skills in areas that will help industry & commerce to become more profitable: to increase the level of awareness of those skills within industry.
- To provide easy access to an impartial advice & support service in all aspects of technology transfer and to the full range of training, technical & professional skills needed for the effective implementation of technological change.
- Through the national network of RTCs, to interchange appropriate technology with other regions of the country.

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Simply, the ERTC is a practical way in which new & existing technologies, materials, processes, practices & techniques from laboratories, R & D and education may be transferred to, and between, companies to be translated into profitable commercial applications in industry.

The ERTC is happy to work closely with other organisations, whose aims do not conflict with the aims of the Centre, in providing more efficient & better focused business services to the enterprises in the region. It is keen to establish partnerships, formal & informal, with other organisations.

Services & benefits to members

Specific products & services are detailed on individual data sheets. However, the ERTC's services fall into three broad groupings: brokerage, consultancy and information provision.

Resources & services available to members include:

- a database of industrial activity in the region,
- a developing textbase of technology profiles of members,
- a database of relevant products & services provided in the region,
- an index of academic skills in the region,
- access to subscription databases and to the data available through the national network of RTCs,
- meetings, workshops, fora, seminars & conferences on relevant technologies, industrial best practice & training,
- a "dial-up" tape-based news facility for members seeking information,
- the formation of specialist groups of members in focused areas of technology,
- a regular newsletter, "Technology & Business", and
- a membership directory.

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The ERTC provides support in:

- the commercial application of new & existing technologies,
- increasing the awareness of EC & UK technical standards and grants,
- the exploitation of under-utilised facilities & resources,
- the closer matching of education & training to the needs of industry,
- the introduction & efficient use of new materials,
- the identification of sources of materials, equipment, services, training, grants & funding,
- the encouragement of collaborative research & joint ventures, particularly between large & small enterprises,
- the expansion of markets for products & services, and for the licensing of existing products, and
- the adoption of industrial best practice in quality, design, manufacturing & safety.

Members benefit through:

- increased revenue from inward & outward licensing of technology,
- increased income, for academic members, from the provision of training & consultancy that is matched to members' explicit needs,
- the better use of under-utilised resources,
- the more rapid identification of suppliers of useful goods & services,
- reduced investment in keeping abreast of developments in technology, materials & good industrial practice, and
- increased exposure for their products & services, through inclusion on the ERTC's database and through circulation of directories in the region & through the national network of RTCs.

The staff of the ERTC deal with enquiries by 'phone, fax & telex, and by visits to members' premises. They play an active rôle in seeking out technology appropriate for transfer, both from companies & to companies. They can identify problems in industry that are amenable to solution by the application of new or established technology, or best practice.

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APPENDIX B

INTERVIEW OUTLINE

1. INTRODUCTION (Telephone)

Good .... it's Mike Anstey from the Applied Research and Consultancy Centre at Putteridge Bury. I would be grateful if I could come over to see you to talk about regional assistance for small firms.

WHY ? WHAT ARE WE GOING TO TALK ABOUT ?

The meeting would permit us to run over any problems you may be having with the business and to look at your plans for the future, in order to see if there are and current DTI or EEC schemes or other national or international intitiatives or forms of assistance which could be used to halp solve your problems, or which may assist in achieving your plans.

2. FIELD INTERVIEW

The first thing I have to do is to identify any key problems facing your business. What do you consider to be the key or major problems currently facing your business ? (Head up Key Problem Record Forms - three maximum).

What I need to do is to get a clear picture of how you see the causes of these problems, their effects, and what you think is required to solve them. I intend to get back to you with sugestions of any DTI or EEC schemes, any organisations or information, or other national or international initiatives, which you may like to consider.

(Complete one Key Problem Record Form for each key problem)

How do you see the main elements of your problem with .....

What do you consider are the main causes of your problem with .....

What do you see are the main effects of your problem with .....

I would now need to try to get a clear picture of your view of what is required to solve your problem with ..... What do you think is required ?

IF GOING WELL

In order to try to assess the importance of the requirements that you have identified I would be grateful if you could rank the three requirements that you consider to be the most important in order to solve your problem with .....

IF NOT

What's the most important, ... and next ?

REPEAT FOR OTHER PROBLEMS

What about the plan or plans that you may have for the future of the business. What would be the main elements of your plan for the future. How do you see the business developing ?

I need to try to get a clear picture of what you consider are the main objectives of your plan.

In order to try to assess the importance of your objectives I need to know which you consider to be the most important.

(Check back each - 'so you consider that .....is the ..... most important objective of your plan')

What do you recon you need to achieve your objectives ? and for .....?

(note requirements for each in turn)

Which do you consider to be the most important ? ..... and the next ?

KEY PROBLEM RECORD FORM

STATEMENT OF PROBLEM

PERCEPTION OF CAUSE OF PROBLEM

PERCEPTION OF EFFECTS OF PROBLEM

PERCEPTION OF SOLUTIONS
WHAT IS REQUIRED TO SOLVE PROBLEM

PERCEPTION OF IMPORTANCE (BY RANKING) OF REQUIREMENTS

BUSINESS PLAN RECORD FORM

STATEMENT OF MAIN POINTS OF PLAN

PERCEPTION OF MAIN OBJECTIVES OF PLAN

PERCEPTION OF IMPORTANCE (BY RANKING) OF MAIN OBJECTIVES

PERCEPTION OF REQUIREMENTS
WHAT IS REQUIRED TO MEET OBJECTIVES

PERCEPTION OF IMPORTANCE (BY RANKING) OF REQUIREMENTS

APPENDIX C

PROBLEM - STAGE TWO RECORD FORM

BRIEF STATEMENT OF PROBLEM

PERCEPTION OF TECHNOLOGY (IF ANY) WHICH RELATES TO PROBLEM

PERCEPTION OF WHAT IS REQUIRED FOR TECHNOLOGY TO BE CONSIDERED AS A VALID OPTION

PERCEPTION OF IMPORTANCE OF REQUIREMENTS FOR TECHNOLOGY TO BE CONSIDERED AS A VALID OPTION

1.

2.

3.

4.

PLAN - STAGE TWO RECORD FORM

BRIEF STATEMENT OF PLAN

PERCEPTION OF TECHNOLOGY (IF ANY) WHICH RELATES TO PLAN

PERCEPTION OF WHAT IS REQUIRED FOR TECHNOLOGY TO BE CONSIDERED AS A VALID OPTION

PERCEPTION OF IMPORTANCE OF REQUIREMENTS FOR TECHNOLOGY TO BE CONSIDERED AS A VALID OPTION

1.

2.

3.

4.